

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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*Tracking and Data Acquisition for
Ranger Missions VI-IX*

N. A. Renzetti

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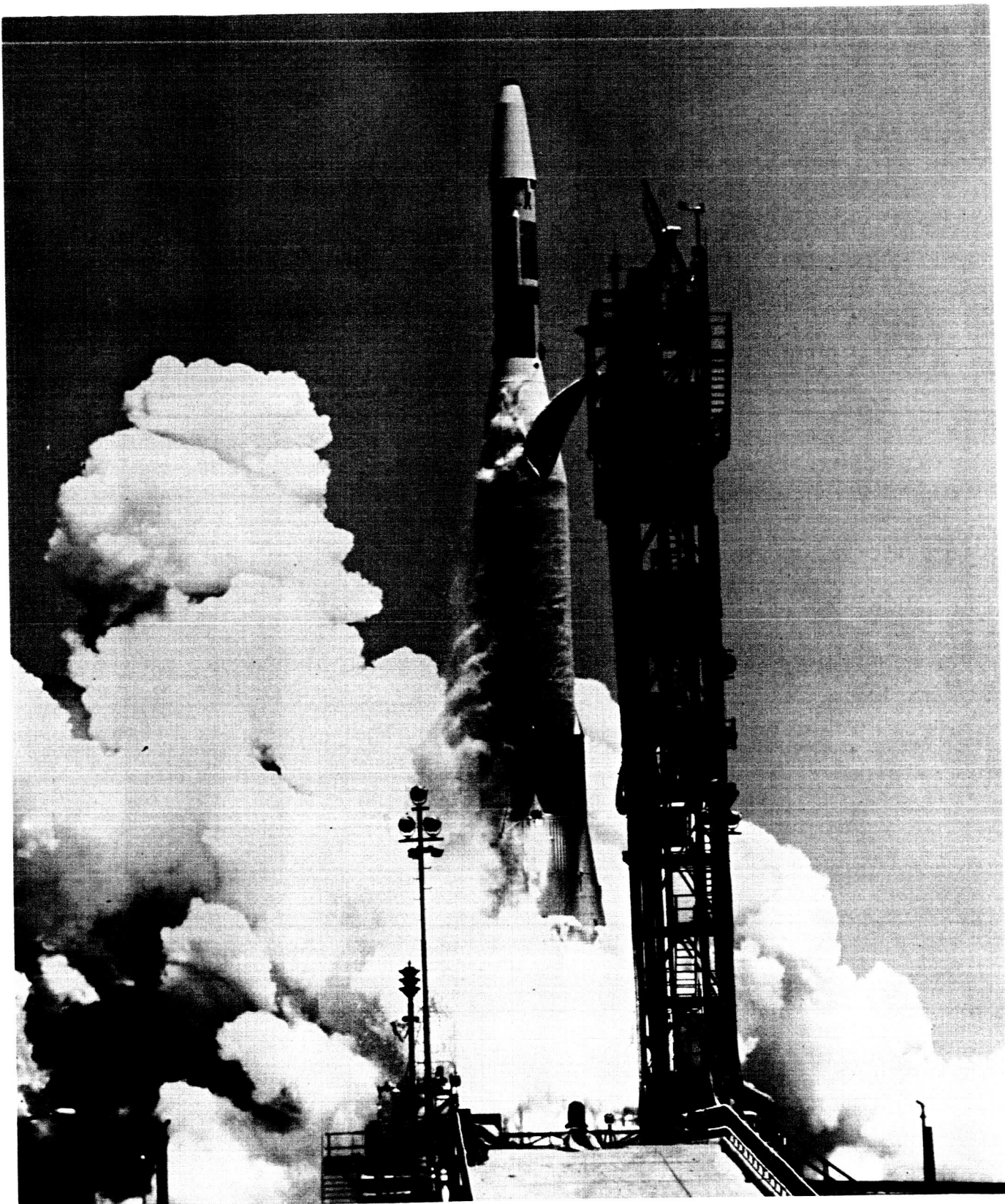
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**JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA**

September 15, 1966



Ranger launching

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N. A. Renzetti



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for Tracking and Data
Acquisition

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September 15, 1966

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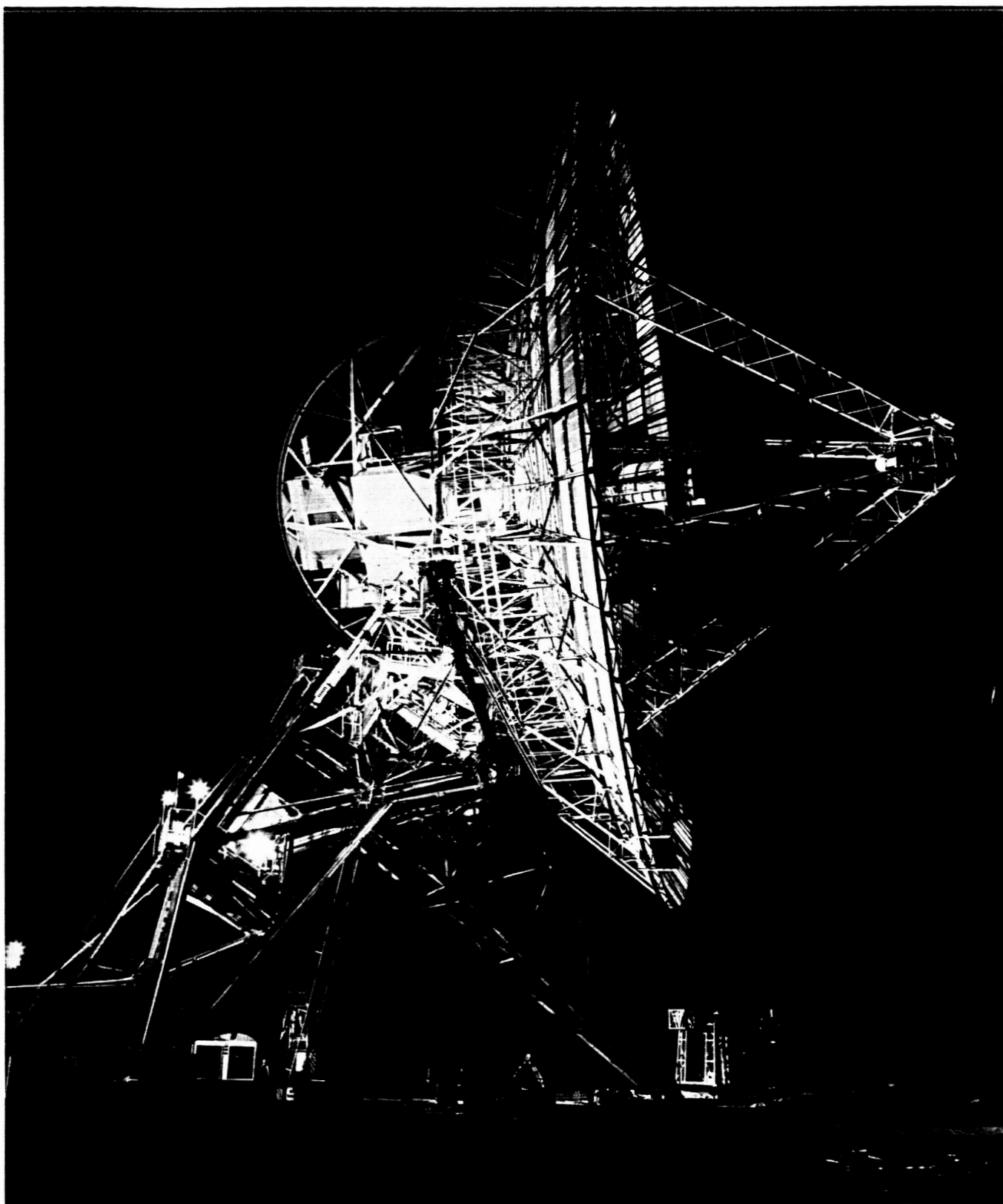
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DSIF 85-ft antenna

ABSTRACT

This document summarizes the technical activities of the NASA/JPL Deep Space Network in support of Missions VI-IX of the *Ranger* Project. This work includes a synopsis of each mission, a comprehensive account of the tracking operations, and a brief evaluation of individual DSIF station performance. The tracking and data acquisition support provided by AFETR sites, Goddard Space Flight Center, and the Space Flight Operations Facility at the Jet Propulsion Laboratory are also delineated.

I. INTRODUCTION

This Memorandum summarizes the technical activities of the NASA/JPL Deep Space Network (DSN), the Air Force Eastern Test Range (AFETR), the Goddard Space Flight Center (GSFC), the Manned Space Flight Network (MSFN), and the Satellite Tracking and Data Acquisition Network (STADAN) stations in support of Missions VI-IX of the *Ranger* Project. Elements of the DSN supporting these missions included: the Deep Space Instrumentation Facility (DSIF); the Space Flight Operations Facility (SFOF); and the Ground Communications System (GCS) of interstation communications.

This document also provides a historical record of the framework within which the technical data were obtained, transmitted in real-time, or near-real-time, and stored on magnetic and paper tapes, DSIF station logs, reports, and various types of instrumentation recordings. A limited description of spacecraft and launch vehicle performance is included to convey an understanding of the Tracking and Data Acquisition (T&DA) activities supporting the missions.

The National Aeronautics and Space Administration (NASA), through its Office of Space Sciences, established the *Ranger* Project at the Jet Propulsion Laboratory (JPL) of the California Institute of Technology in 1960. The project objectives were to develop the technology of spacecraft for lunar, planetary, and interplanetary exploration; to conduct a number of scientific experiments and lunar photographic missions; and to gather data which could be useful in planning manned flights to the Moon and planets.

Through its offices of Space Flight Operations, NASA established the DSN in 1958-9 and gave the Jet Propulsion Laboratory the responsibility for designing, developing, engineering, installing, and operating the network. In addition, JPL was to provide the supporting research and development necessary to maintain the network at the state-of-the-art level in space communications. During the early portion of the *Ranger Block III* series of flights, the DSN Office was not yet formed as the head of the network. The DSIF with a Systems Manager and Operations

Manager comprised the primary element of *Ranger* T&DA support. In so far as practical, this document covers *Ranger* T&DA support provided under the network configuration prevailing during the period under discussion.

The DSIF configuration for the *Block III* missions consisted of four space communication stations located at three permanent installations approximately 120 degrees apart in longitude around the Earth. In addition, two transportable (trailer-mounted) stations were used for the near-Earth portion of the trajectory. This configuration comprised a precision tracking and communications system capable of providing command, control, tracking, and data acquisition during the *Ranger* flights.

The four permanent DSIF stations, which utilized 85-ft, steerable, paraboloidal antennas and associated

electronics, were Pioneer (DSIF-11) and Echo (DSIF-12) at Goldstone, California; DSIF-41 at Woomera, Australia; and DSIF-51 at Johannesburg, Republic of South Africa. A mobile spacecraft monitoring station, now known as DSIF-71, was located at Cape Kennedy and was used to obtain spacecraft radio transmitter frequency after liftoff, and to record spacecraft telemetry during the early part of the flight. A Mobile Tracking Station (DSIF-59), was located at Johannesburg, South Africa and was used to provide immediate post-injection tracking and telemetry reception and acquisition information for the larger stations.

While command capabilities existed at all permanent DSIF stations. DSIF-12 at Goldstone was utilized for terminal maneuver control of the spacecraft and for receiving the data (engineering, scientific, and TV pictures) transmitted from the spacecraft. This station also em-

Table 1. DSIF L-band master equipment list

Equipment	DSIF stations					
	Goldstone		Australia	South Africa		Cape
	11	12	41	51	59	71
Antennas:						
85-ft paraboloid HA-DEC	○	○	○	○		
10-ft paraboloid AZ-EL					○	
6-ft paraboloid AZ-EL						○
Low noise amplifiers:						
Maser	○	○				
Paramp	○	○	○	○		
Feeds and duplexers:						
Tracking feed			○	○	○	
Horn feed	○	○				
Acquisition aid			○	○		
Dipole						○
Diplexer		○	○	○	○	○
Receiver:						
960 Mc GSDS modified					○	○
960 Mc GSDS	○	○	○	○		
Transmitter:						
50 w backup		○				
10 kw (operated 200 w for <i>Ranger Block III</i>)		○	○	○		
25 w		○			○	○ ^a
Rubidium standard		○				
Synthesizer		○				
Doppler:						
One-way		○	○	○	○	○
Two-way		○	○	○	○	
Two-way two-station noncoherent		○	○	○	○	
Equipment	DSIF stations					
	Goldstone		Australia	South Africa		Cape
	11	12	41	51	59	71
Recording:						
7 Channel magnetic tape	2	2	2	2	2	2
Strip chart:						
36 Channel ultraviolet	○	○	○	○	○	○
8 Channel hot stylus	○	○	○	○	○	
Acquisition aids:						
10-cps modulator		○	○	○		
Mission-oriented equipment:						
Command system		○	○	○		
Command interrupt		○				
Telemetry decommutator/encoder		○	○	○		
Telemetry discriminator		10	10	10	10	
Prime RCA TV GSE		○				
Secondary RCA TV GSE	○					
JPL TV GSE		○ ^b	○	○		
Prime test equipment:						
Test transponder	○	○	○	○	○	○
Closed-loop RF system	○	○	○	○	○	○
Bit error checker		○				
Optical star tracker		○				
Miscellaneous:						
Intersite microwave	○	○				
Coordinate converter	○	○				

^aTransmitter used for prelaunch only.

^bRedundant system backup mag tape converter/FR-800.

bodied a 50-w transmitter for backup command capabilities. DSIF-11 at Goldstone provided redundant receiving and magnetic tape recording of the received video data.

Table 1 shows the L-band master equipment list of the DSIF during *Ranger Block III*; antenna and receiver parameters are listed in Tables 2 and 3, respectively.

During *Ranger* Missions VI-IX, the DSN elements accomplished all required T&DA objectives and experienced no failures of consequence.

Fig. 1 shows the organization comprising the NASA Office of Tracking and Data Acquisition and the personnel involved in implementing the DSN during *Ranger*

Table 2. DSIF antenna parameters

Station	Antenna type	Reflector size, ft	Tracking rate, deg/sec		Antenna gain, db		Antenna ellipticity, db		Excess noise temp, °K
			Elevation or hour angle	Azimuth or declination	Receiving	Transmitting	Receiving	Transmitting	
Goldstone Echo, DSIF-12	HA-Dec	85	0.7	0.7	$45.5^d \pm 0.6$	$41.7^b \pm 0.8$	$< 1.0^\circ$	3.0 ± 0.1	$43^\circ + 0 - 15$
Goldstone Pioneer, DSIF-11	HA-Dec	85	0.7	0.7	$45.5^d \pm 0.5$	—	$< 1.0^\circ$	—	15 ± 5
Woomera	HA-Dec	85	0.7	0.7	$44.5^e \pm 0.6$	—	1.4 ± 0.1	—	$43^\circ + 0 - 15$
Johannesburg	HA-Dec	85	0.7	0.7	$44.5^e \pm 0.6$	$41.7^b \pm 0.8$	1.4 ± 0.1	3.0 ± 0.1	$43^\circ + 0 - 15$
MTS	Az-EI	10	10.0	10.0	$22.8^f \pm 0.5$	$23.3^f \pm 0.5$	0.6 ± 0.2	2.7 ± 0.5	$100^\circ \pm 50$

^aGain for matched polarization includes bridge loss.

^bSum channel of tracking antenna used for transmitter feed. Gain shown is for matched polarization right-hand circular. Does not include ellipticity but includes bridge loss.

^cAntenna temperature is for 960-Mc tracking feed except for Goldstone Cassegrain. Sky temperature of 0°K is assumed.

^dCircularly polarized Cassegrain listening feed. Gain figures are eliminated and are for matched polarization.

^eEstimated.

^fGain includes sum channel bridge loss and is for linear isotropic source. Tolerance includes possible variations due to ellipticity and measurement errors. Matched polarization will increase gain figure by 3 db.

^gSum channel of tracking antenna used for transmitter feed. Gain includes sum channel bridge loss and is for linear isotropic source.

Table 3. DSIF receiver parameters

Item	Goldstone Az-EI	Goldstone HA-Dec	Woomera	Johannesburg	MTS
Nominal frequency, Mc ^a	960.05 ± 0.03	960.05 ± 0.03	960.05 ± 0.03	960.05 ± 0.03	960.05 ± 0.03
Receiver noise figure, db, $F = T_e/T + 1$	$1.8^b \pm 0.2$	$0.5^b \pm 0.2$	$1.8^b \pm 0.2$	$1.8^b \pm 0.2$	$6.3^c \pm 0.5$
Receiver transmission line loss, db	$0.3^d \pm 0.2$	0.1 ± 0.05	0.3 ± 0.2	0.3 ± 0.2	$0.80^d \pm 0.2$
Receiver diplexer, db	0.4 ± 0.2	—	—	$0.4^e \pm 0.2$	—
Loop noise bandwidth at threshold, cps	20 ± 4 (60 ± 10)	20 ± 4 (60 ± 10)	20 ± 4 (60 ± 10)	20 ± 4 (60 ± 10)	20 ± 4 (60 ± 10)
Threshold, dbm, 20 cps $2BW_{L_0}$	-162 ± 1.5	-162 ± 1.5	-162 ± 1.5	-162 ± 1.5	-155 ± 1.5
Maximum input signal level, dbm	-65	-65	-65	-65	-45
Residual phase modulation crystal oscillator phase jitter contribution	less than 3 deg ^f pp	less than 3 deg ^f pp	less than 3 deg ^f pp	less than 3 deg ^f pp	less than 3 deg ^f pp

^a960.05 Mc is basic two-way received frequency. 960.15 Mc and 960.25 Mc are one-way capsule listening frequencies.

^b $220 \pm 30^\circ\text{K}$ is the estimated system noise temperature for the parametric receiver system. $75 \pm 10^\circ\text{K}$ is the measured system noise temperature for the maser system.

^cMeasured at 30 Mc. The MTS figure was measured with noise injected at the diplexer.

^dConsists of 0.30 db from hybrid bridge to diplexer; 0.3 db for diplexer; 0.1 db from diplexer to front end. 0.1 db is included for mismatch losses.

^eEstimated figure.

^fFor input signal level of -60 dbm with 150-cps noise bandwidth.

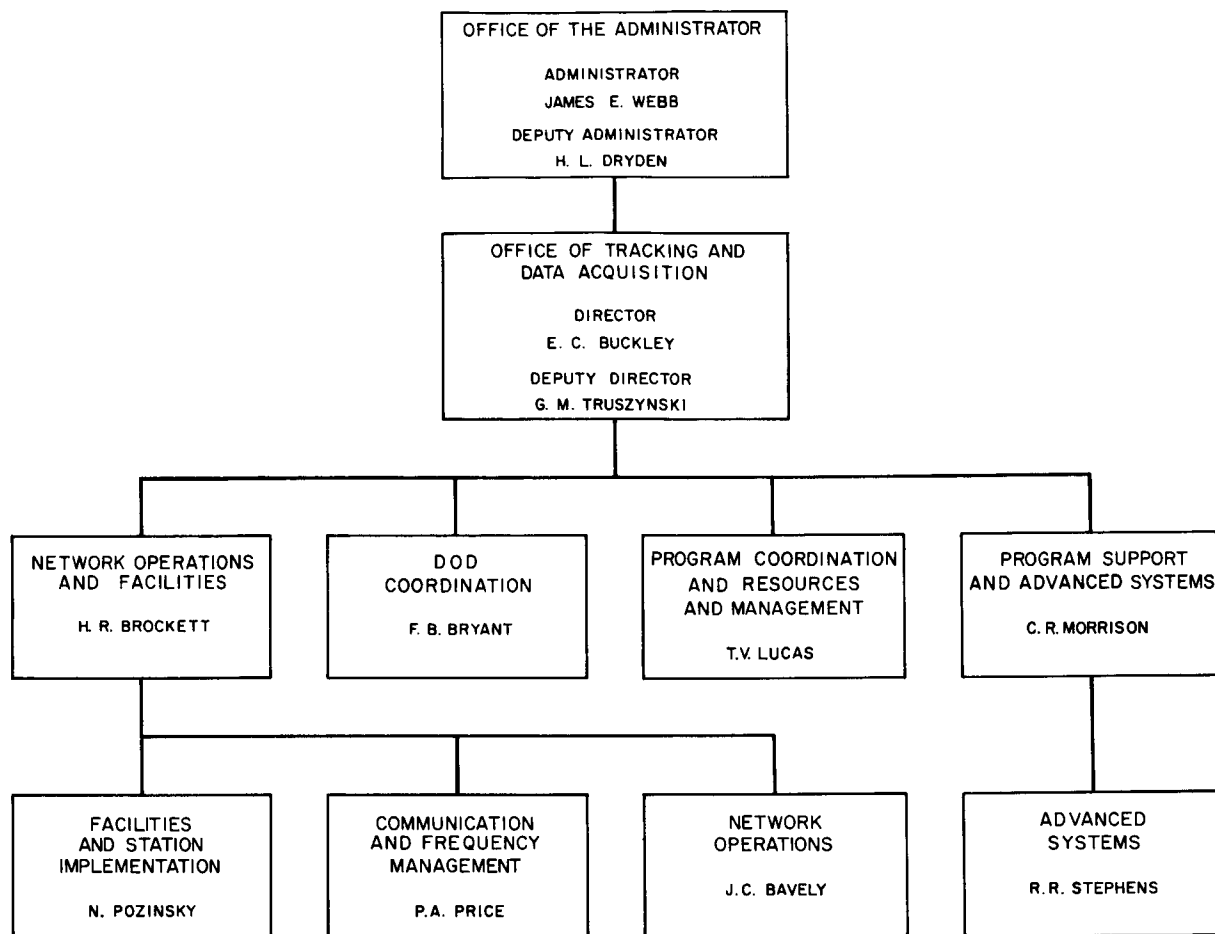


Fig. 1. NASA organization of space sciences, 1963

Missions VI-IX. Similarly, Fig. 2 shows an organizational breakdown of JPL during these *Ranger* missions, Fig. 3 presents the organizational chart of the *Ranger* Project at JPL, and Fig. 4 shows the DSIF organization for the missions.

Elliptical Earth orbits, injection, and lunar impact trajectories were used for *Rangers VI-IX*. In each case, the launching was conducted at Cape Kennedy with the *Atlas/Agena* launch vehicle. Following liftoff, control of the flight was transferred from the Kennedy Space Center at the Cape to the SFOF or Space Flight Operations Center (as it was known in earlier flights) at JPL in Pasadena.

The five *Ranger* missions covered in this Memorandum are presented in chronological order and include the following subject matter:

1. Flight plan—the plan for conducting flight operations and the expected achievements.
2. Mission synopsis—a recapitulation of significant events occurring throughout the mission.
3. DSIF configuration—the equipment component of each station, including the mission-oriented equipment.
4. DSIF preparation for mission—the station and net operational readiness and performance evaluation tests.
5. Tracking operations—a chronology of DSIF operations during the mission.
6. Performance evaluation—a discussion of accomplishments and operational problems encountered during the mission.
7. Participation of non-DSIF agencies—included the SFOF, the Goddard MSFN, and the AFETR, or Atlantic Missile Range as it was known during the early *Block III* phase.

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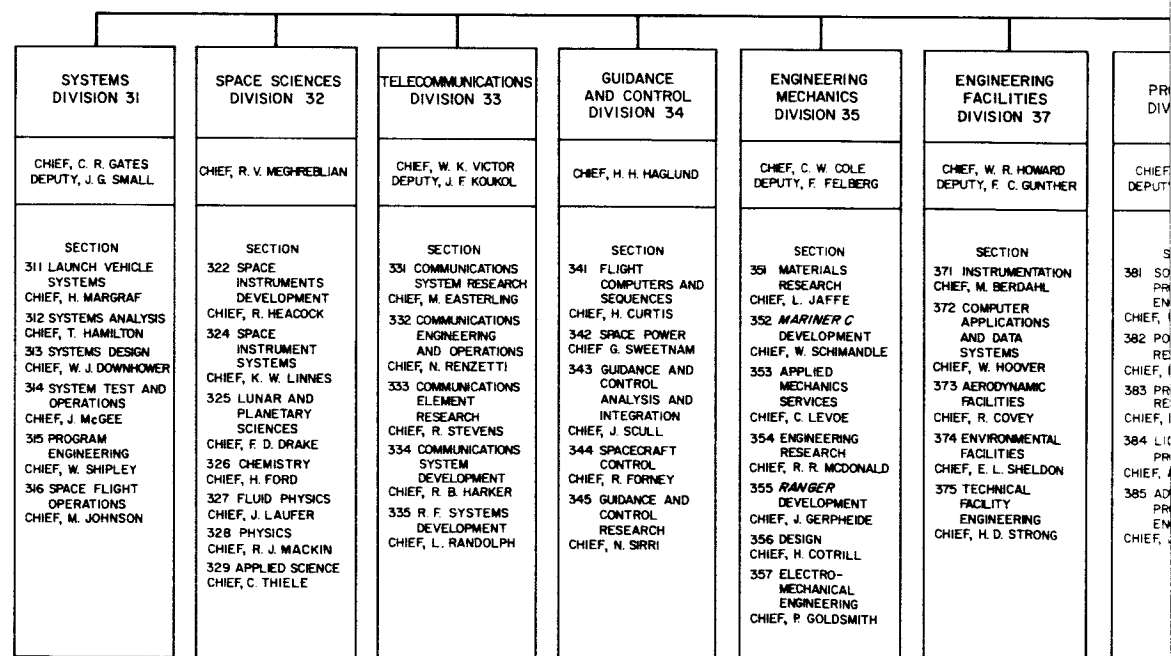
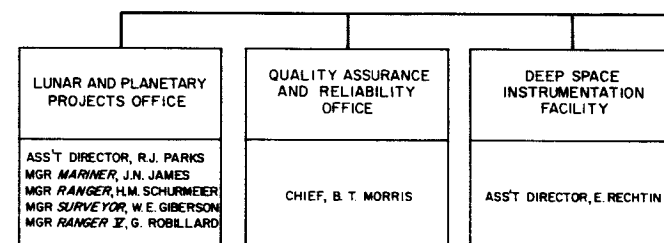
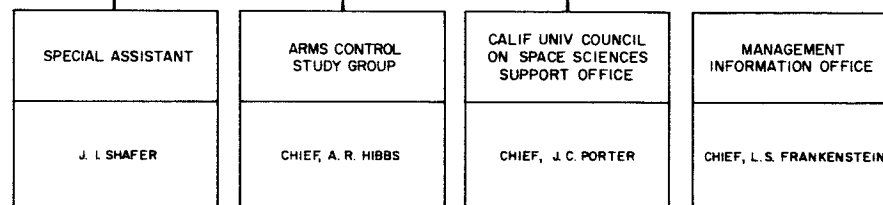
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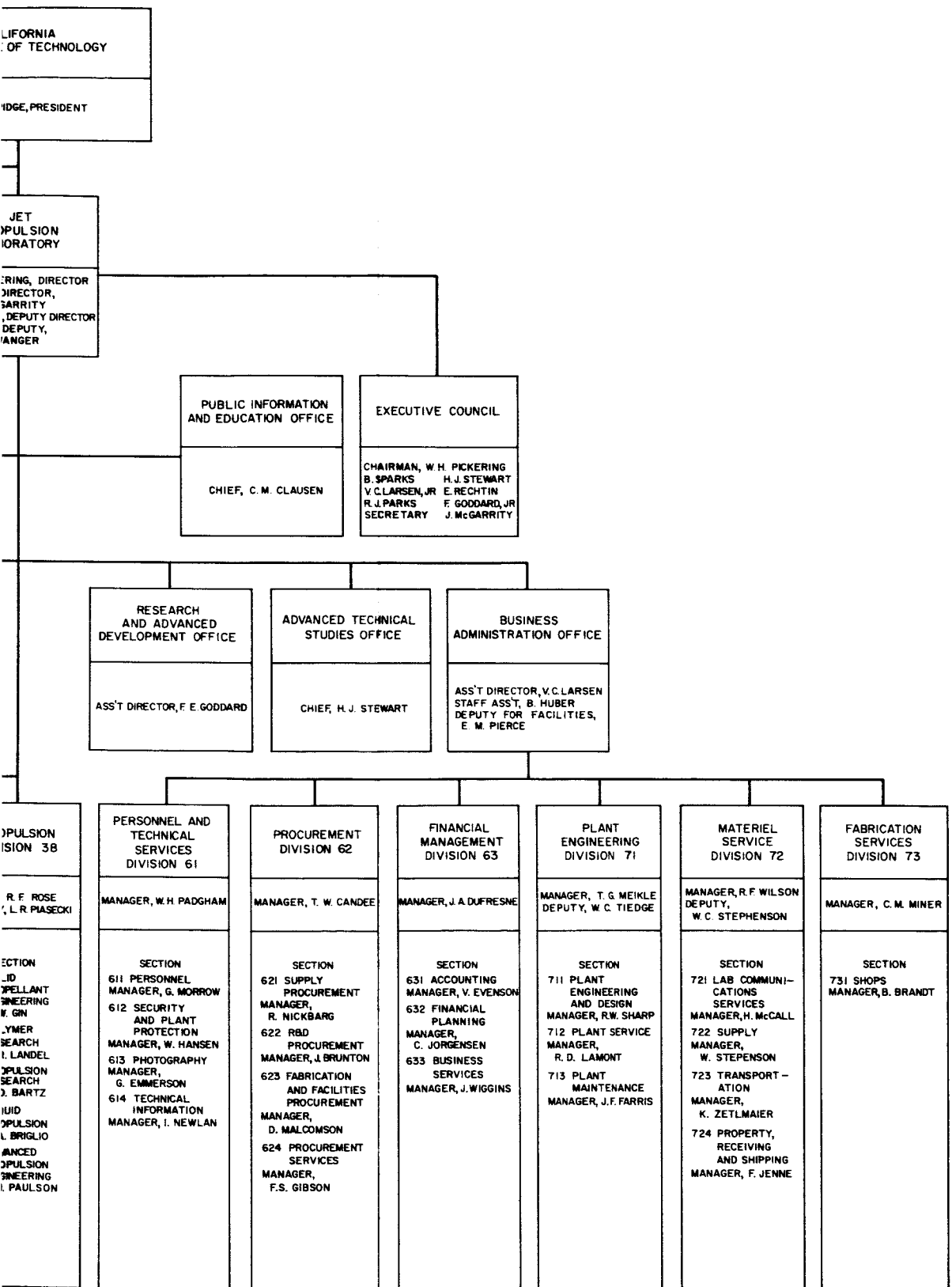


Fig. 2. JPL organization, 1963

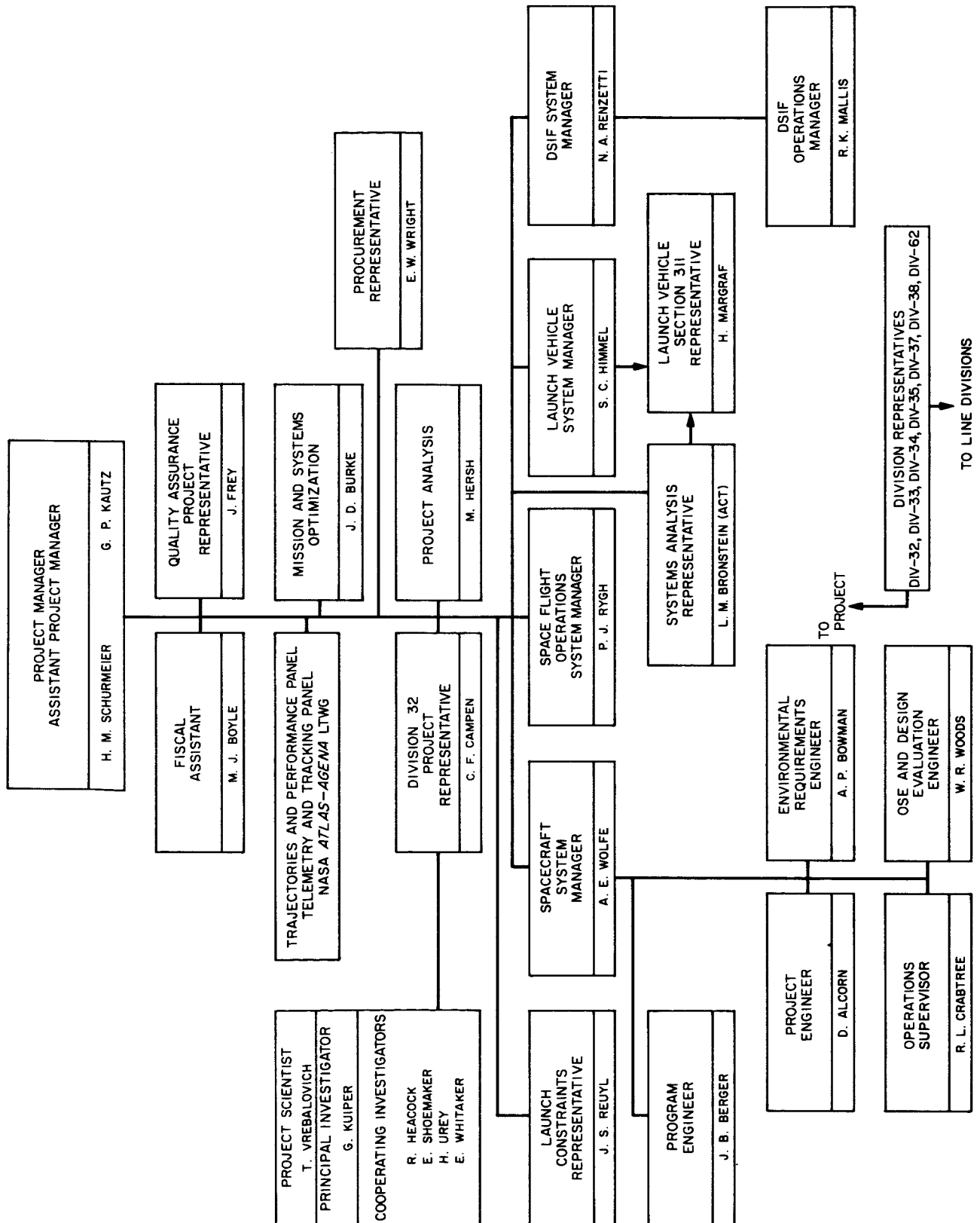


Fig. 3. JPL Ranger project organization

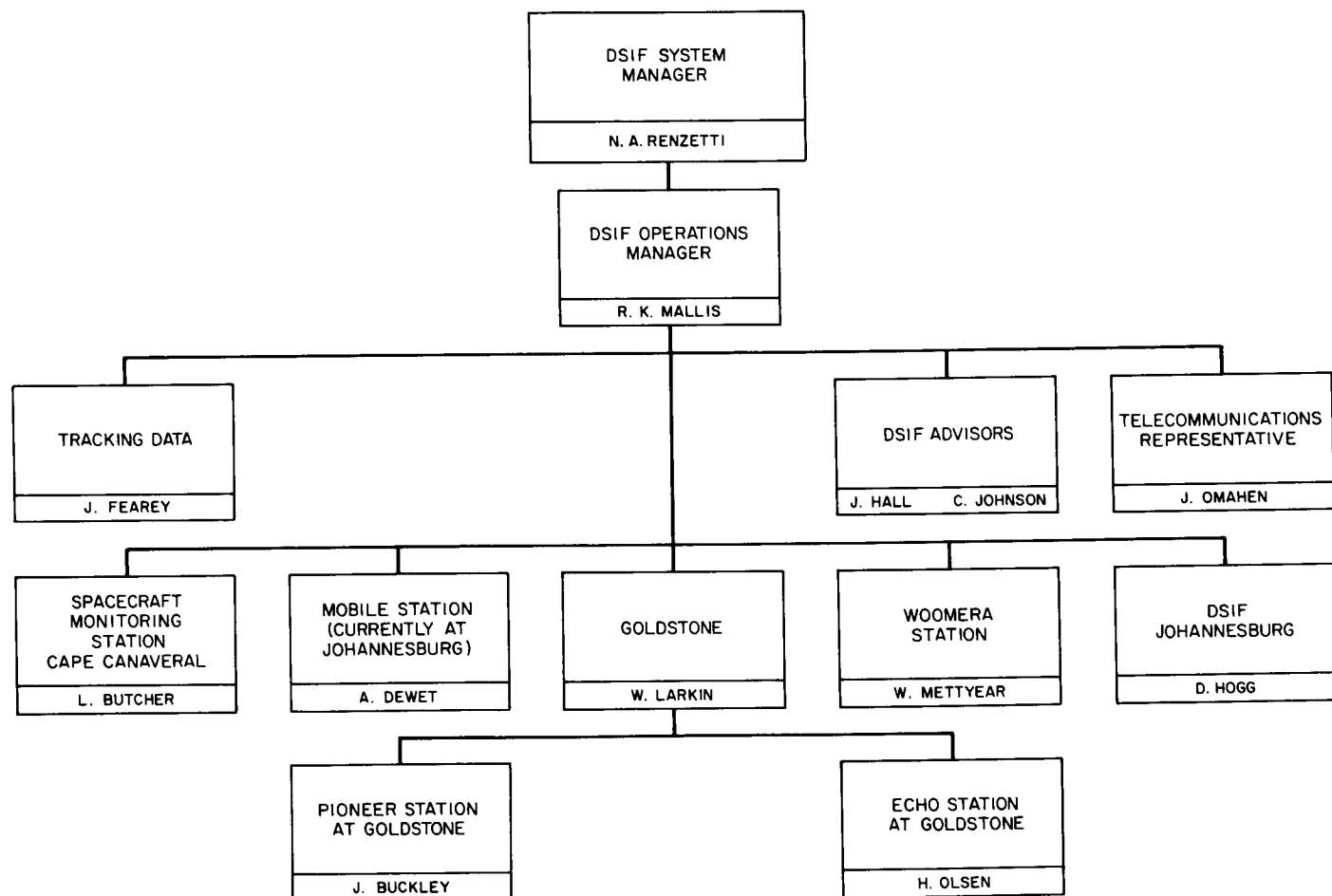


Fig. 4. DSIF organization for Ranger

A. Scope

The technical information provided in this Report concerns the T&DA and associated support functions, including communication, transmission, processing, and reduction of data for the *Ranger* missions. Preflight support of the missions was documented in the form of operational readiness tests at the individual DSIF stations and at the various non-DSIF participating agencies. Tracking operations summaries for each of the DSIF stations are presented in a narrative format with emphasis on critical phases of flight control. In addition, edited station logs and organization charts are included in the appendix at the end of this document as supplementary information for each *Ranger* mission.

B. Ranger Project Background

The *Ranger* Project was initiated in 1959 with the following basic mission elements:

1. *Atlas D/Agna B* launch from Cape Kennedy with a parking orbit ascent trajectory.
2. Attitude-stabilized spacecraft employing solar power and capable of a midcourse maneuver and high-gain directional communications.
3. World-wide tracking, telemetry, and command facilities.
4. Integrated space-flight operational control, computation, and data handling.

Block I of the Project consisted of two test missions (*Rangers I* and *II*) conducted in 1961 and designed as non-lunar oriented engineering development flights for verification of the parking orbit launch concept and soundness of the spacecraft design. Both of these flights experienced launch-vehicle failures. The spacecraft remained in their parking orbits as low altitude Earth satellites, which permitted the testing of some spacecraft design elements and the acquisition of some scientific data, but the test objectives were not met.

Block II included a lunar rough landing capsule which incorporated a seismometer experiment, a retro-propul-

sion system, a lunar approach television, and gamma-ray experiments. The three missions, *Rangers III-V*, comprised *Block II* of the 1962 Project which utilized sterilized spacecraft. Both spacecraft design and launch vehicle performance were successfully demonstrated, but, unfortunately, on separate attempts. The *Ranger III* mission demonstrated spacecraft midcourse maneuver, attitude control, and communications capability, but was unable to impact the Moon. *Rangers IV* and *V* had satisfactory vehicle performance; *Ranger IV* impacted the Moon but the spacecraft had failed early in the flight; the *Ranger V* spacecraft also malfunctioned early in flight.

Ranger Block III consisted of the four missions, *Rangers VI-IX*, which are covered in the appended tracking and data acquisition report. *Block II* featured a new payload comprising a six-camera television subsystem designed to operate during the last 10 to 15 min before impact on the Moon. The first mission, *Ranger VI*, launched January 30, 1964, performed satisfactorily throughout the flight up to the terminal phase, when the television subsystem failed to operate. A number of modifications were made on the spacecraft bus and major TV subsystem.

The second mission (*Ranger VII*) launched July 28, 1964 was successful, and returned more than 4,300 close-up lunar photographs before impacting in a region since named Mare Cognitum on July 31, 1964.

Ranger VIII, the third *Block III* mission, was launched February 17, 1965 and was completely successful. The spacecraft transmitted a total of 7,137 photographs of the lunar surface prior to impacting in Mare Tranquillitatis.

The fourth and final mission of the project, *Ranger IX*, was launched March 21, 1965 and successfully met all objectives. The spacecraft came within 2.76 mi of its selected aiming point in Crater Alphonsus; returning 5,814 television pictures from all cameras; and achieved, in the final pictures, a photographic resolution of approximately 12 in.

II. RANGER VI MISSION

A. Flight Plan

Ranger VI was the fourth flight aimed at lunar impact and had the following objectives:

1. Scientific Experiments

A major objective was to obtain high resolution television pictures of the Moon's surface.

2. Engineering Experiments

- a. Experiment with trajectory error correction (mid-course maneuver).
- b. Experiment with terminal attitude maneuver.
- c. To further the development of basic spacecraft technology through performance evaluation of the *Ranger* spacecraft.

Although resembling previous *Rangers* in concept, the *Ranger VI*, as shown in Fig. 5, was advanced in configuration and capability. The new scientific instrumentation in *Ranger VI* consisted of a television subsystem containing two full-scan (Channel A) and four partial-scan (Channel B) cameras.

The spacecraft was to be confined within its thermal shroud for environmental protection during the launch phase, with the shroud being ejected following sustainer burnout. At the conclusion of the first *Agena* burn, the spacecraft was to be in a coasting or parking orbit. A second ignition and burn of the *Agena*, concluding with spacecraft injection, was to be followed by the separation of *Ranger VI* from the *Agena*. After separation, the spacecraft's Sun and Earth acquisition sequence could be initiated. The solar panels would be extended, the attitude control system activated, and the high-gain antenna rotated to a preset hinge angle. Solar sensors controlling the attitude control jets were to point the spacecraft roll axis toward the Sun, thus placing the solar cell power system in operation. The spacecraft was to turn about the roll axis until the antenna beam lay in the plane defined by the spacecraft roll axis and the Earth. While maintaining the antenna beam in this plane, the Earth sensors were to command the antenna to move so that its propagation axis intersected the Earth, thus establishing a high-gain communication link. The spacecraft would then continue to coast in the attitude of Sun and Earth acquisition.

After a suitable tracking period, the required trajectory corrections would be computed and the corrective maneuver commands transmitted to the spacecraft. The resulting midcourse maneuver would turn the spacecraft through the prescribed angles, supplying the necessary thrust correction, and then return the spacecraft to its Sun and Earth orientation.

Upon approaching the lunar surface, a terminal maneuver would be performed to align the cameras for television pictures of the Moon. Commands from the Earth would initiate the terminal maneuver. The TV subsystem was to be turned on by a command from the spacecraft at 15 min before impact; a backup command for the turn-on would also be sent from the DSIF.

At 13 min 40 sec before impact, the TV subsystem was to begin taking and transmitting pictures from both the wide-angle and narrow-angle cameras. The pictures were to begin at a nominal altitude of 1400 km, and continue until impact. The entire vehicle was to be destroyed on impact with the lunar surface.

B. Mission Synopsis

Ranger VI was launched by an *Atlas D/Agena B* vehicle from Cape Kennedy on January 30, 1964 at 154909¹. An abnormal event occurred during the launch phase at 155130 when the TV subsystem experienced an inadvertent turn-on of Channel 8 telemetry, which lasted 67 sec. Otherwise the spacecraft performed properly during the launch, and data were received by the Spacecraft Monitoring Station (DSIF-71) at Cape Kennedy until loss of lock at 155700. The boost phase of the launch appeared normal with the *Atlas* booster functioning as programmed. The *Agena B* performed properly throughout its flight, with all preinjection events occurring at near-nominal-times. The spacecraft was successfully launched into its lunar intercept trajectory, with injection occurring at 161649.

Because of the appearance of Channel 8 data during the launch phase, it was feared the TV subsystem may have come on early. To ensure the capability of a rapid turnoff of the TV subsystem, if it were on, the Johannesburg (DSIF-51) station was instructed to acquire the spacecraft in two-way lock as soon as possible and be ready to transmit the backup command for turnoff.

¹All times in this document are given at Greenwich Mean Time (GMT).

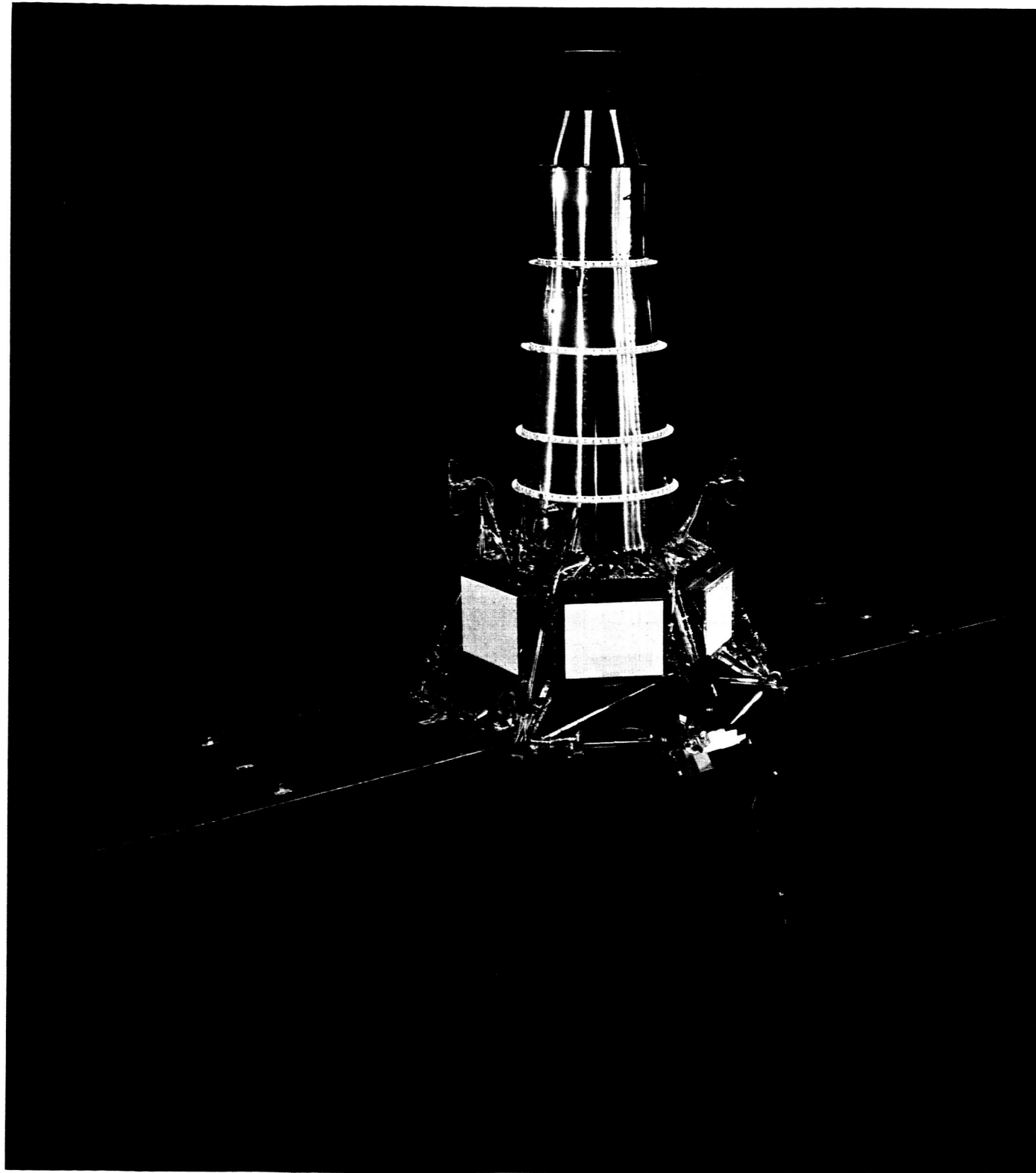


Fig. 5. Ranger VI spacecraft

Johannesburg acquired the spacecraft at 161944 in two-way lock and reported no evidence of the video signal. To ensure against a failure in the video monitoring system at Johannesburg, the Woomera station (DSIF-41) was also instructed to look for the video signal. Woomera acquired the spacecraft at 163353, and reported no video signal.

The Woomera station confirmed solar panel extension and initiation of the Sun acquisition sequence at 165007 and 165201 respectively. Earth acquisition was confirmed by Woomera at 192002.

The first ground commands were sent to the spacecraft by the Johannesburg station on January 30 at 210800, resulting in the changeover from the omni antenna to the high-gain antenna.

The spacecraft trajectory was such that an early mid-course correction could be chosen to cause impact in the desired lunar region. The midcourse commands were initiated January 31 at 083039 by the Goldstone station, resulting in perfect execution of the maneuver at 085817. A terminal maneuver was unnecessary because the space-

craft was correctly oriented for desired terminal configuration. On February 2, at impact minus 19 min, television Channel A went into warmup apparently initiated by the spacecraft TV backup clock. At about impact minus 15 min, TV Channel 13 went into warmup as the result of a backup command sent by the Goldstone station. Both TV cameras should have indicated full power at impact minus 10 min, and video should have been received by Goldstone, but neither occurred. Another backup command was sent by Goldstone at impact minus 9 min in an attempt to turn on the TV subsystem, but it had no effect. A third and final command was sent to the spacecraft in what proved to be a futile attempt to turn on the TV subsystem. Both TV cameras apparently remained in the warmup mode until impact. The *Ranger VI* spacecraft impacted the lighted side of the Moon in the Sea of Tranquility at 092433 on February 2, 1964.

C. DSIF Configuration

The following paragraphs describe the mission-oriented equipment installed throughout the DSIF for the *Ranger VI* mission. The overall equipment configuration for each station is illustrated in Fig. 6-11. Table 4 presents the

Table 4. DSIF capabilities and characteristics for *Ranger VI*

	DSIF 71 launch station	DSIF 59 mobile tracking station	DSIF 11 Goldstone Pioneer station	DSIF 12 Goldstone Echo station	DSIF 41 Woomera station	DSIF 51 Johannesburg station
1. Antenna size	6-ft (Az-El) (No angle data)	10-ft (Az-El)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)
2. Maximum angular rate	Manually operated	20 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes
3. Antenna gain (960 Mc) tracking feed Horn feed	— 20.5 db	23.5 db \pm 0.2 —	— 45.7 db \pm 0.8	— 45.7 db \pm 0.8	43.7 db \pm 0.9 —	43.7 db \pm 0.9 —
4. System noise temp in °K	1000 \pm 100	950 \pm 100	110 \pm 20	110 \pm 20	240 \pm 25	240 \pm 25
5. Transmitter power	—	25 w	—	200 w (50 w backup)	200 w	200 w
6. Data transmission Angles-doppler Telemetry	— Real-time ^a	Near-real- time None	Near-real- time ^b Record only	Near-real- time ^b Near-real-time Real-time ^a	Near-real- time Near-real-time Real-time ^a	Near-real- time Near-real-time Real-time ^a
7. Decommuted telemetry	No	No	No	Yes	Yes	Yes
8. Command capability	No	No	No	Yes	Yes	Yes
9. Air freight time to JPL	2 days	7 days	1 day	1 day	7 days	7 days

^aSent to the Telemetry Processing Station (TPS) via wide-band telephone line.

^bAngle data not the result of autotrack operation.

capabilities and characteristics of the DSIF in support of the mission.

1. Telemetry Decommutator and Teletype Encoder

A new telemetry decommutator and teletype encoder was installed at all DSIF stations. This equipment formats telemetry data in a manner that allows a greater percentage to be transmitted in near-real-time than was possible with earlier equipment.

2. Two Hundred Watt Transmitter and Command System

A 200-w transmitter and command system was installed at the Woomera station. The addition of this equipment provided the capability of maintaining two-way lock with

the spacecraft on a 24-hr-a-day basis, and of transmitting commands to the spacecraft at any time.

3. Modulation System of 10 cps, and Special Subcarrier Oscillators

The 10-cps modulation system, and special subcarrier oscillators were incorporated throughout the DSIF. The addition of this equipment provides rapid verification of two-way lock, and additional telemetry reduction capabilities.

4. Video Recording System

Video recording systems were installed at the overseas stations. This equipment was installed to record the television signals, in the event they occurred at a nonstandard time.

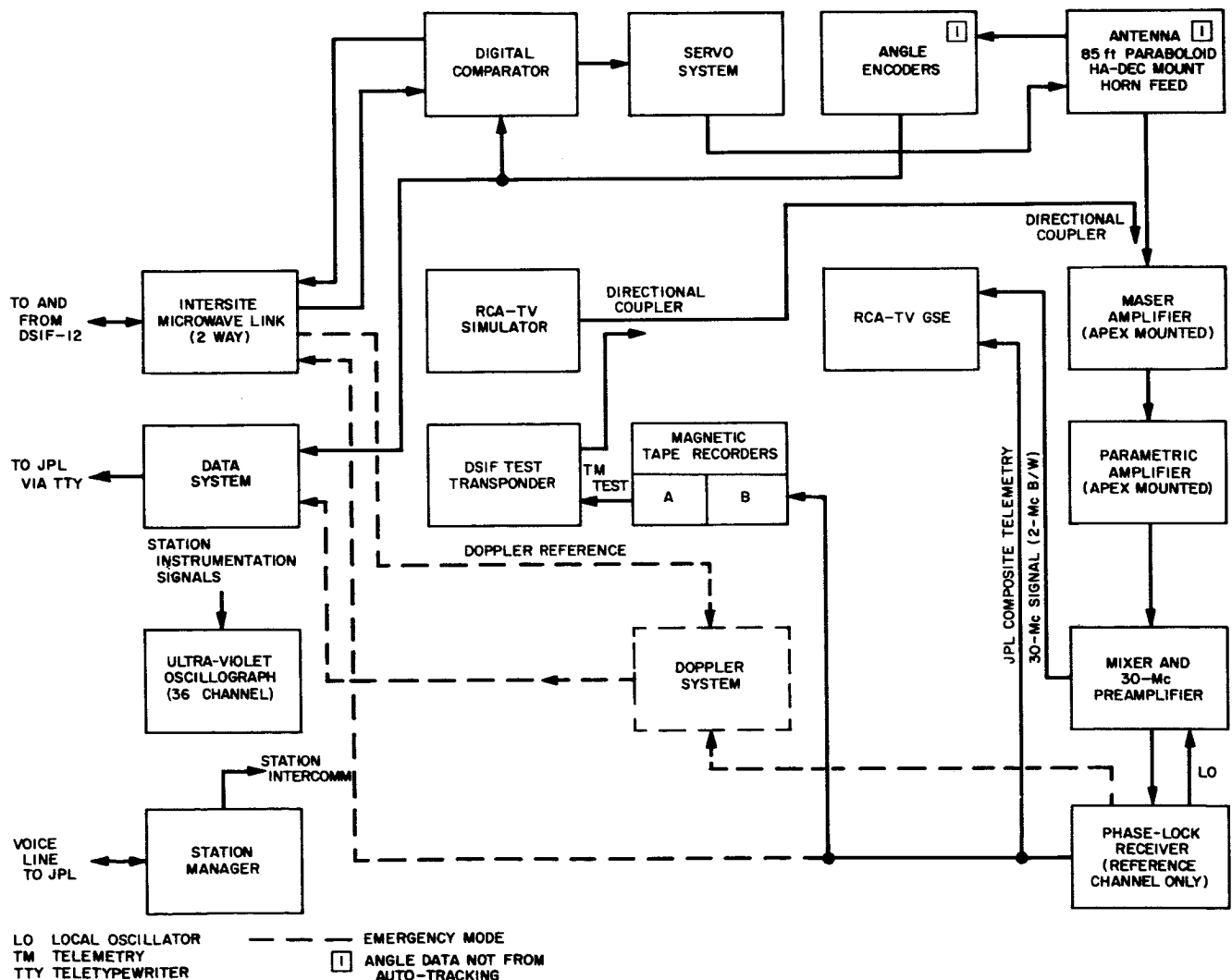
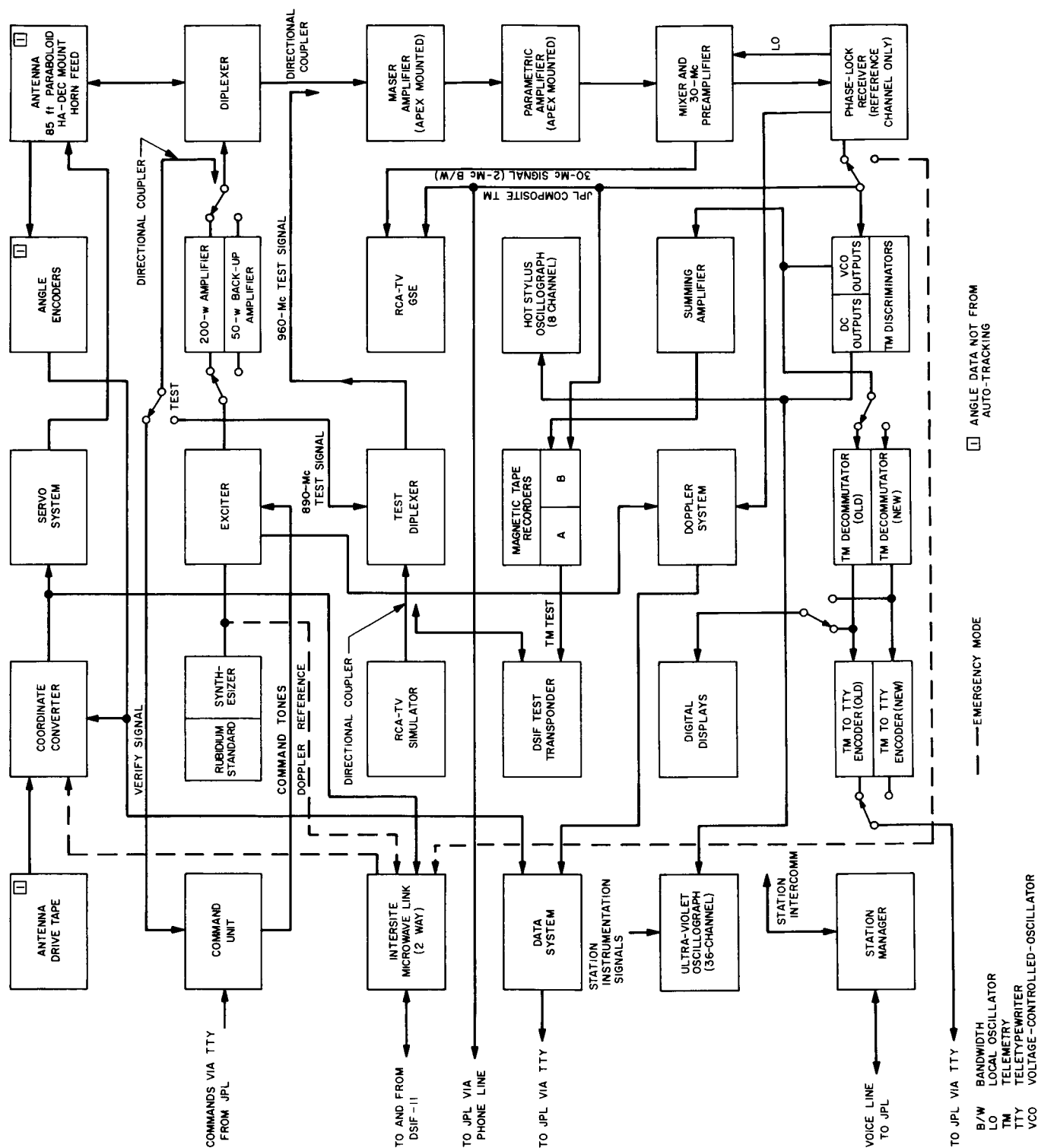


Fig. 6. Pioneer (DSIF-11) configuration for Ranger VI



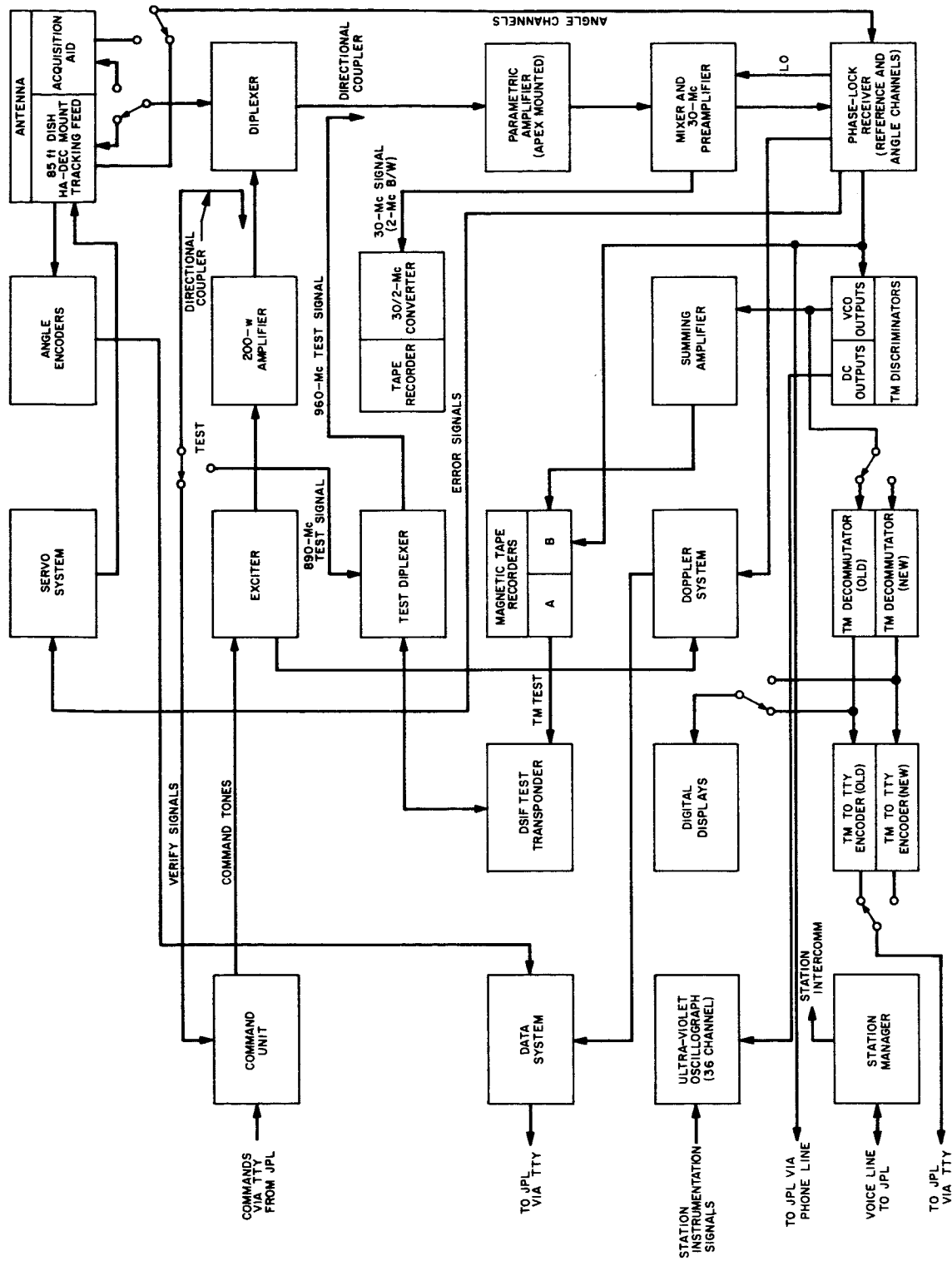


Fig. 8. Woomera (DSIF-41) configuration for Ranger VI

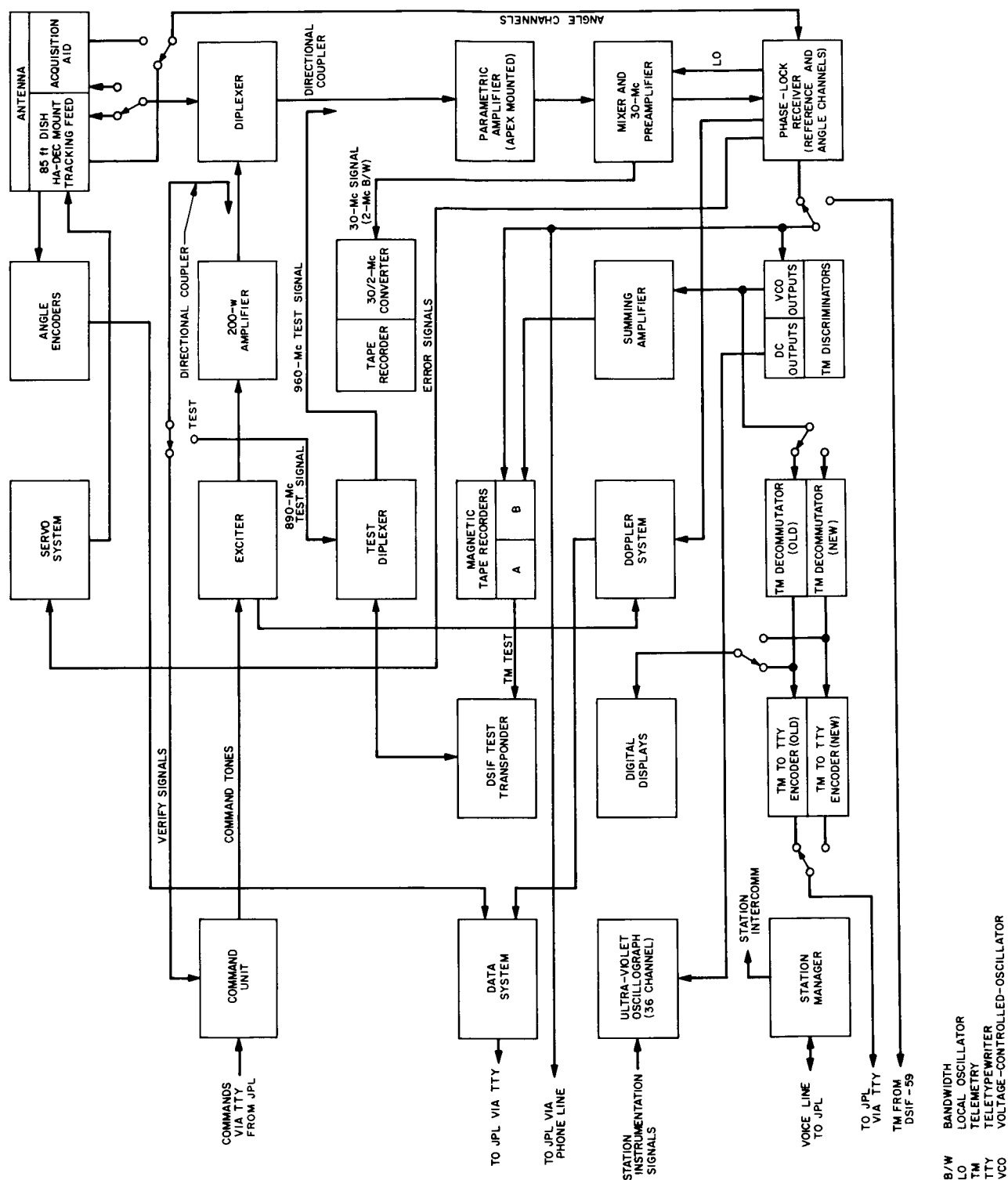


Fig. 9. Johannesburg (DSIF-51) configuration for Ranger VI

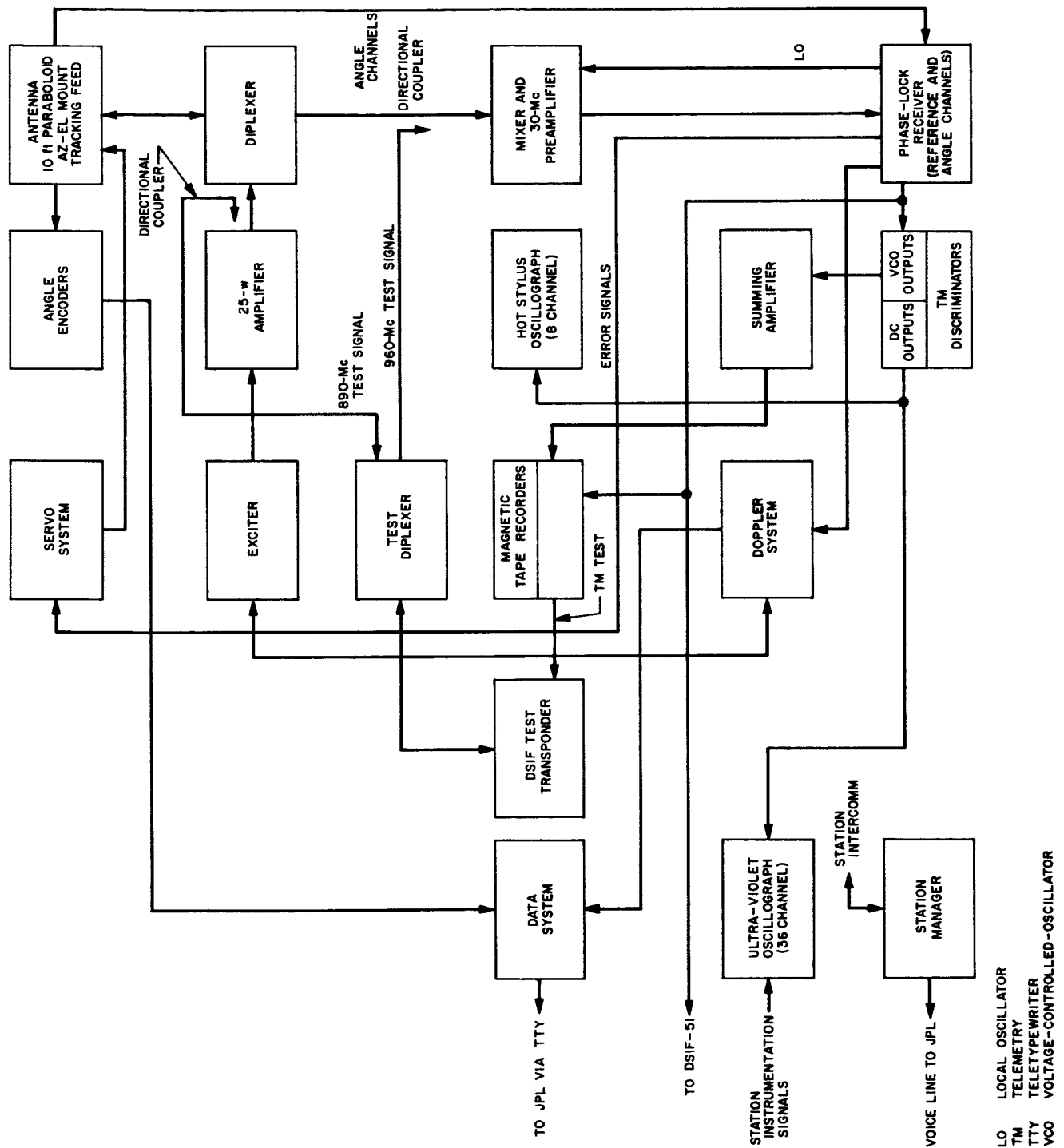


Fig. 10. Mobile tracking station, Johannesburg (DSIF-59) configuration for Ranger VI

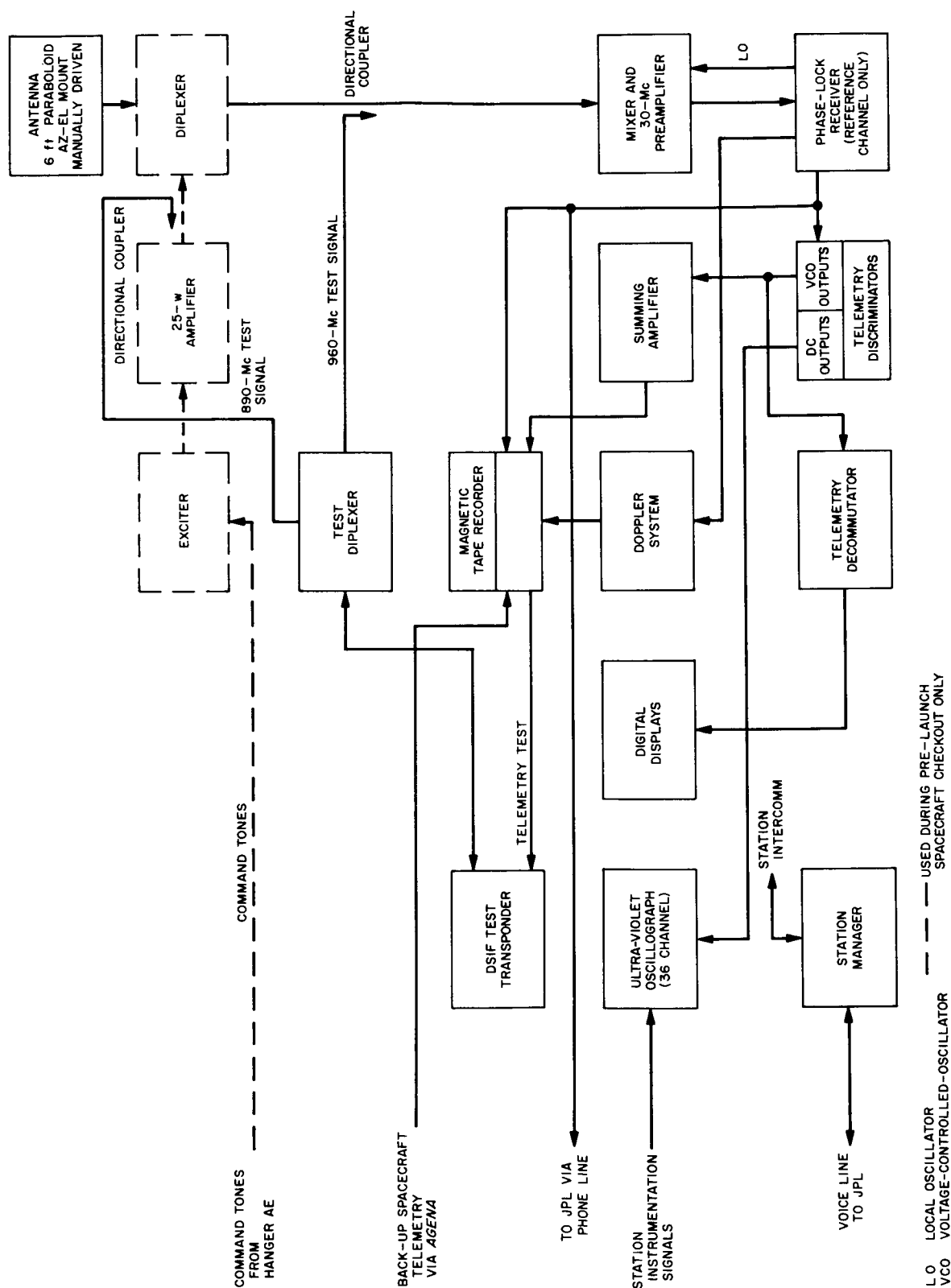


Fig. 11. Spacecraft monitoring station, Cape Kennedy (DSIF-71) configuration for Ranger VI

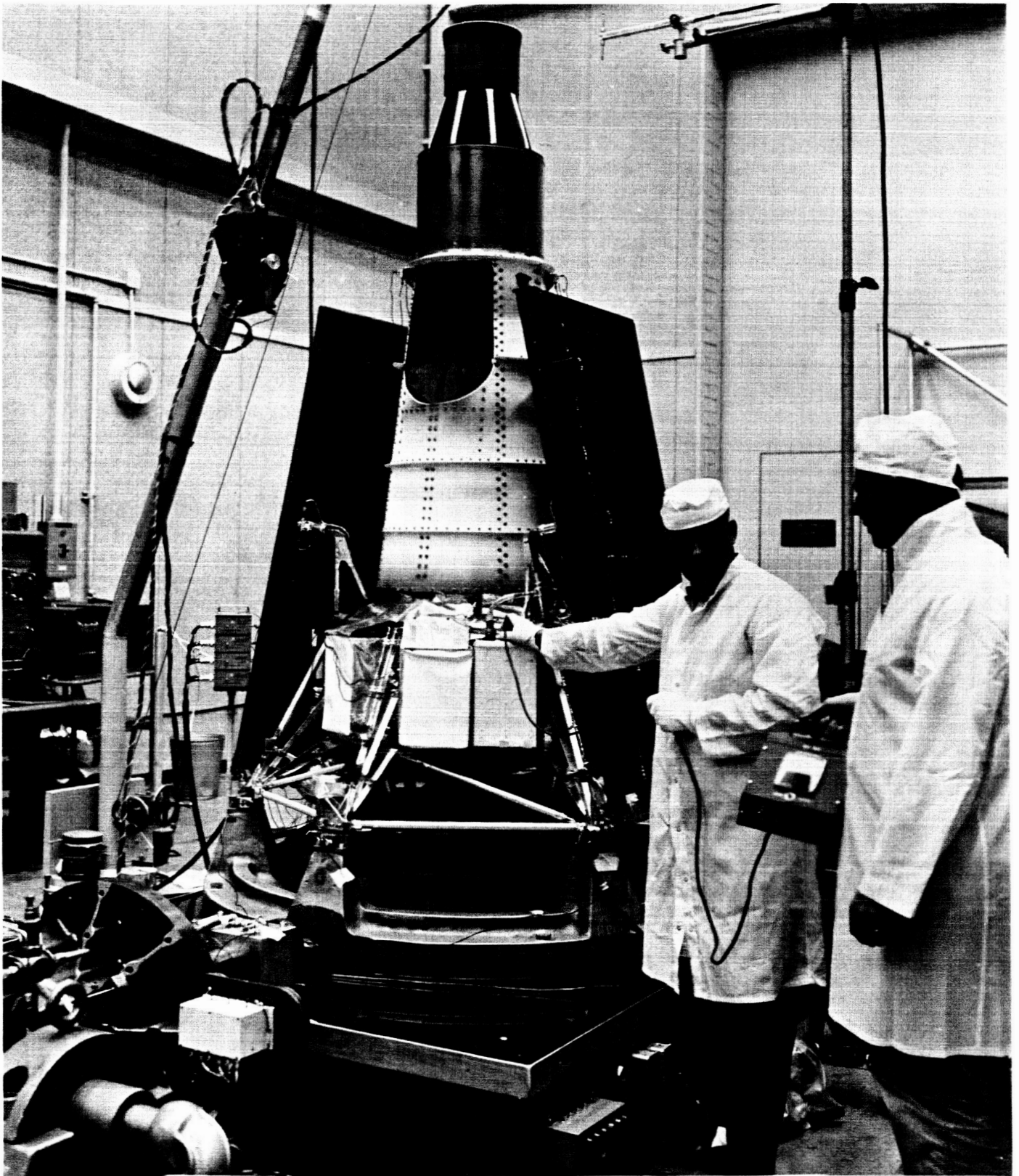


Fig. 12. Spacecraft preparation

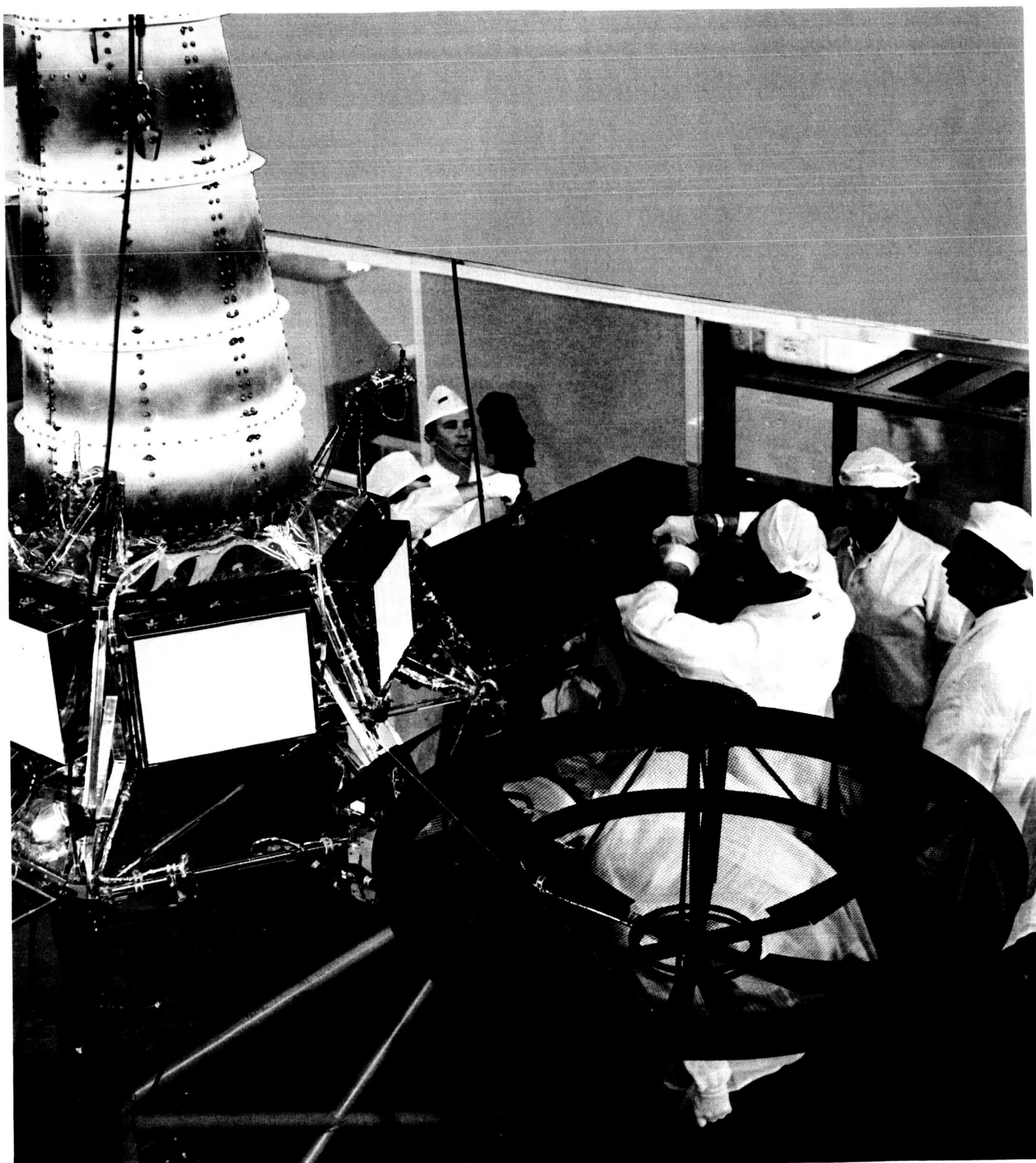


Fig. 13. Spacecraft preparation

D. DSIF Preparation for Mission

About October 1, 1963 the DSIF began checkout and preparation of station subsystems, concurrent with final preparation of the spacecraft itself (Fig. 12 and 13). A number of tests were conducted during the months preceding the *Ranger VI* Mission, the most significant being compatibility, net integration and operational readiness. The final operational readiness test involving the entire DSIF was conducted on January 24 and 25 with all systems "in the green" for the *Ranger VI* launch.

E. Tracking Operations

1. Launch to Midcourse Maneuver

Launch of the spacecraft occurred at 154909 on January 30, 1964. At the time of launch, the Spacecraft Monitoring Station (SMS) at Cape Kennedy (DSIF-71) was in RF lock and maintained lock until 1557 when the spacecraft set below the horizon. Approximately 3 min after launch, the Spacecraft Data Analysis Team, from telemetry data received from the SMS, reported an indication that the television cameras had turned on early for about 1 min. The Johannesburg station was alerted, and instructed to transmit the TV turn-off command in the event it was on. The spacecraft, because of its flight path characteristics, was not acquired by DSIF-51 until 1620, at which time, no indications of a television turn-on were reported.

The Woomera station, upon acquisition at 1633, confirmed the fact that there was no evidence of a TV turn-on. Consequently, the TV subsystem was assumed to be in a standard mode of operation. Continuous surveillance of the spacecraft by the DSIF began when the DSIF-51 and -59 stations acquired RF lock on the spacecraft at 1620. Subsequent surveillance periods are summarized in Table 5. Event blips were observed by DSIF-41 at near-nominal-time, confirming solar panel extension and Sun and Earth acquisition. The first ground commands were sent to the spacecraft by DSIF-51 on January 30, 1964. Two "clear commands" (RTC-0) were sent at 2108 and 2110, followed by an antenna changeover command (RTC-3) at 2112. This last command switched the spacecraft transmitter from the omni-antenna to the high-gain antenna. A rise in receiver signal strength and the observance of an event blip at 211240 confirmed the antenna changeover.

2. Midcourse Maneuver to Impact

Preliminary spacecraft orbit computations indicated that a trajectory correction was required to achieve lunar impact in the preselected target area. At 0720 on January 31, Goldstone began the procedure required for transmission of the midcourse maneuver commands. (See Table 6 for the commands sent to *Ranger VI* by the DSIF.) All guidance commands were correctly received by the spacecraft, changeover was made from the high-gain to

Table 5. Nominal view periods and actual DSIF tracking periods for *Ranger VI*

Date	DSIF station	Nominal rise (GMT) ^a	Acquisition by station	Nominal set (GMT) ^a	Loss of signal by station	Nominal view period	Actual view period
January 30, 1964	71	—	154902	—	155700	—	013100
	59	—	161844	—	073529	—	151645
	51	161919	161944	163624	164200	001705	002216
	41	163622	163353	232723	235302	065101	071909
	51	184320	184325	070713 ^b	073051	122353	124726
January 31, 1964	11	055656	055838	164342	170700	104646	110822
	12	055656	053121	164342	170650	104646	113529
	41	124846	122500	000516 ^b	003300	111630	120800
	51	201314	201220	072608 ^b	075104	111254	113844
February 1, 1964	11	060253	060845	170641	172550	110348	111705
	12	060253	053740	170641	172550	110348	114810
	41	130821	124610	001041 ^b	003730	110220	115120
	51	202614	202723	073000	075337	110346	112614
February 2, 1964	11	060156	061055	092433	092433.1 ^c	032237	031338
	12	060156	053600	092433	092433.145 ^c	032237	034833

^aBased upon 5 deg elevation angle.

^bSet occurs on next day after rise.

^cTime of lunar impact observed at stations.

Table 6. Ground commands from DSIF to Ranger VI

Command	Initiated (date/GMT)	Verified ^a (GMT)	Sent by DSIF station	Associated telemetry event blips recorded at station
RTC-0	30/20:25:00	202540	41	Not applicable
RTC-0	30/21:08:00	210839	51	Not applicable
RTC-0	30/21:10:00	211040	51	Not applicable
RTC-3	30/21:12:00	211239	51	CH B-20 at 21:12:40
RTC-0	31/07:20:00	072039	12	Not applicable
RTC-0	31/07:22:00	072239	12	Not applicable
SC-1	31/07:24:00	072439	12	CH B-20 at 07:24:41
SC-2	31/07:26:00	072639	12	CH B-20 at 07:26:40
SC-3	31/07:28:00	072839	12	CH B-20 at 07:28:42
RTC-3	31/08:20:00	082039	12	CH B-20 at 08:20:40
RTC-4	31/08:30:00	083039	12	CH B-20 at 08:30:40
RTC-0	31/09:40:00	094039	12	Not applicable
RTC-0	31/09:42:00	094239	12	Not applicable
RTC-3	31/09:44:00	094439	12	CH B-20 at 09:44:20
RTC-0	1/08:10:00	081039	12	Not applicable
RTC-0	1/08:12:00	081239	12	Not applicable
RTC-7	1/09:08:00	090839	12	CH B-20 at 09:08:42
RTC-7	1/09:15:29	091608	12	CH B-20 at 09:16:11
RTC-7	1/09:19:21	092000	12	CH B-20 at 09:20:03

^aVerified by ground station Read-Write-Verify (RWV) system.

Real Time Commands

RTC-0 = Clear command

RTC-3 = Antenna switchover

RTC-4 = Begin midcourse maneuver

RTC-7 = (1st time) Backup TV turn-on

(2nd time) Switch emergency telemetry on/off

(3rd time) Switch emergency telemetry off

Stored Commands

SC-1 = Roll duration

SC-2 = Pitch duration

SC-3 = Velocity increment

the omni-antenna, and the midcourse maneuver execute command was initiated at 0830. The midcourse maneuver began at 083037 and was completed at 085817. The two-way doppler shift during the retro-motor firing, and the time over which the shift occurred, indicated a perfect midcourse maneuver had been executed. After the maneuver, the spacecraft, responding to the central computer and sequencer commands, reacquired the Sun and Earth. Goldstone then sent the command to switch the spacecraft transmitter from the omni-antenna to the high-gain antenna (RTC-3). The *Ranger VI* spacecraft was now in a cruise mode proceeding on a lunar impact trajectory. Based on subsequent orbital computations using postmidcourse tracking data, it was decided a terminal maneuver would not be necessary.

On February 2, at impact minus 19 min television Channel A went into warmup as initiated by the TV backup clock. At about impact minus 15 min TV Channel

B went into warmup as the result of a backup command (RTC-7) sent by Goldstone. Both TV channels should have indicated full power at impact minus 10 min and video should have been received at Goldstone, but neither occurred. Another RTC-7 was sent at approximately impact minus 9 min in an effort to force at least one TV channel into full power, but it had no effect. A third and final RTC-7 command was sent at impact minus 5 min, also without apparent effect. Both TV channels remained in the warmup mode until impact. Impact occurred at 092433 on the lighted side of the Moon at the Sea of Tranquility.

3. Station Tracking Operations

Detailed accounts of tracking operations at each DSIF station are given in the following paragraphs. Edited station logs are presented in the appendix of this document as supplemental information.

a. DSIF-71, Spacecraft Monitoring Station. The station was in one-way lock with the spacecraft at 1426. Signal strength at acquisition was -83 dbm.

Acquisition went very smoothly even though the tracking conditions were not very good. It was an overcast day and the launch vehicle could not be observed. Therefore a remote AGC meter was used during the launch phase. Station performance was satisfactory. Figure 14 shows an external view of the DSIF-71 station.

There were no changes in tracking conditions during the launch phase. The conditions of receiver telemetry during launch phase was very good and all channels were in lock until 1557. The launch tracking was very smooth, and there were no difficulties. The spacecraft was successfully tracked for 471 sec and the average signal level during this time was -87 to -130 dbm. No unexpected significant events occurred. Figure 15 shows operations personnel at DSIF-71.

b. DSIF-59, Mobile Tracking Station operations. The facilities were fully available during the entire mission

but due to the request for Johannesburg to go two-way as early as possible, very little facilities were used. Telemetry was sent via DSIF-51 to the SFOF from 184940 to 190417, in all other respects this station acted only as a backup station for Johannesburg.

At the beginning of the countdown there was a momentary power failure and a slight delay was encountered when the collimation tower polarization drive failed. Due to the failure it was necessary to omit the boresight measurements except at zero polarization; otherwise countdown was uneventful.

There were no significant pre-acquisition occurrences. The spacecraft was acquired at 161844 on the horizon and servo was in auto 12 sec later. The first pass was tracked to well below the horizon and the second pass was picked up before the spacecraft rose. Tracking data was good except during the first two-way lock of Johannesburg when DSIF-59 remained in one-way because it was uncertain as to which lock Johannesburg had acquired. The ground mode should have been 32, not 12. Once the hi-gain antenna was in operation, tracking was

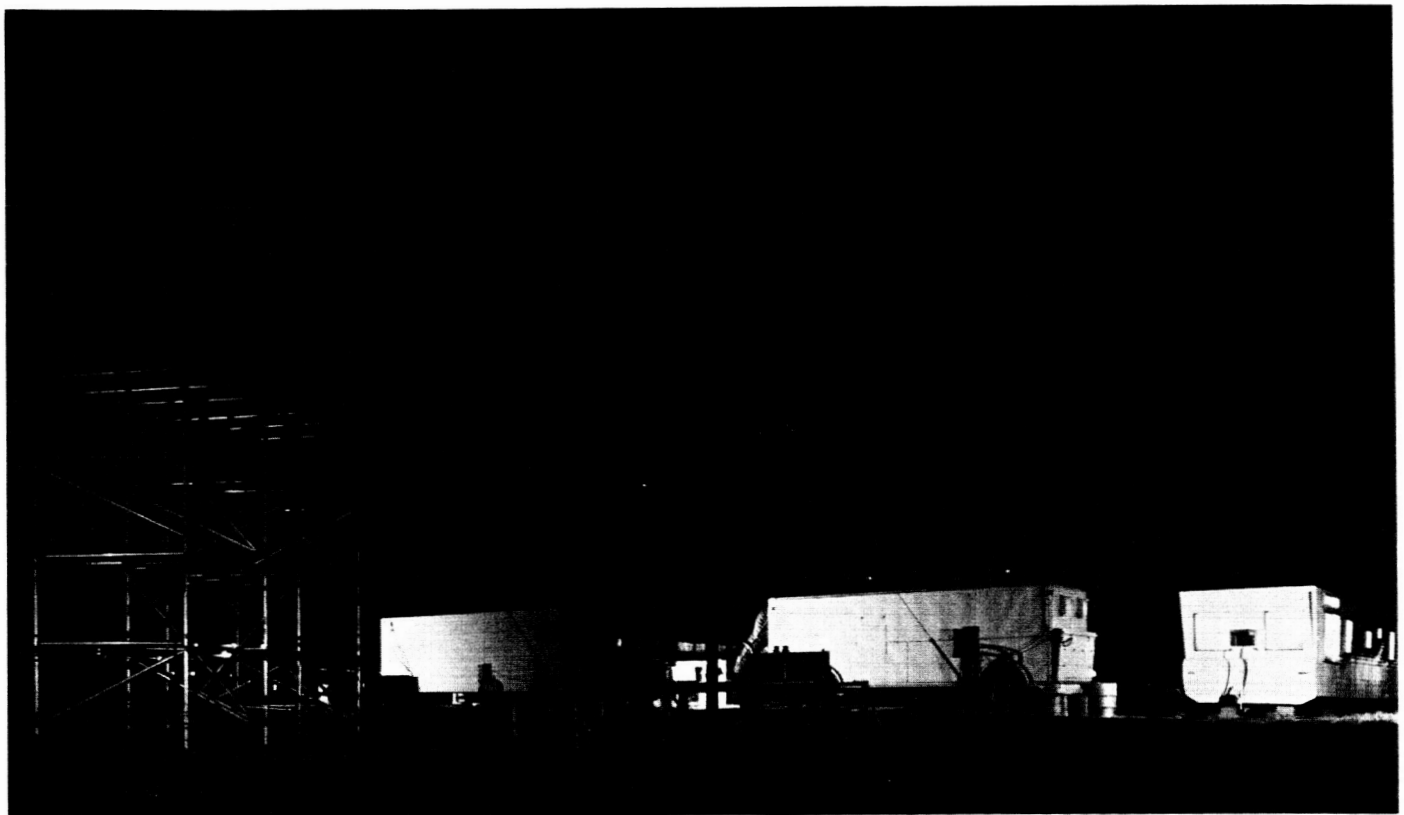


Fig. 14. DSIF-71, spacecraft monitoring station, Cape Kennedy

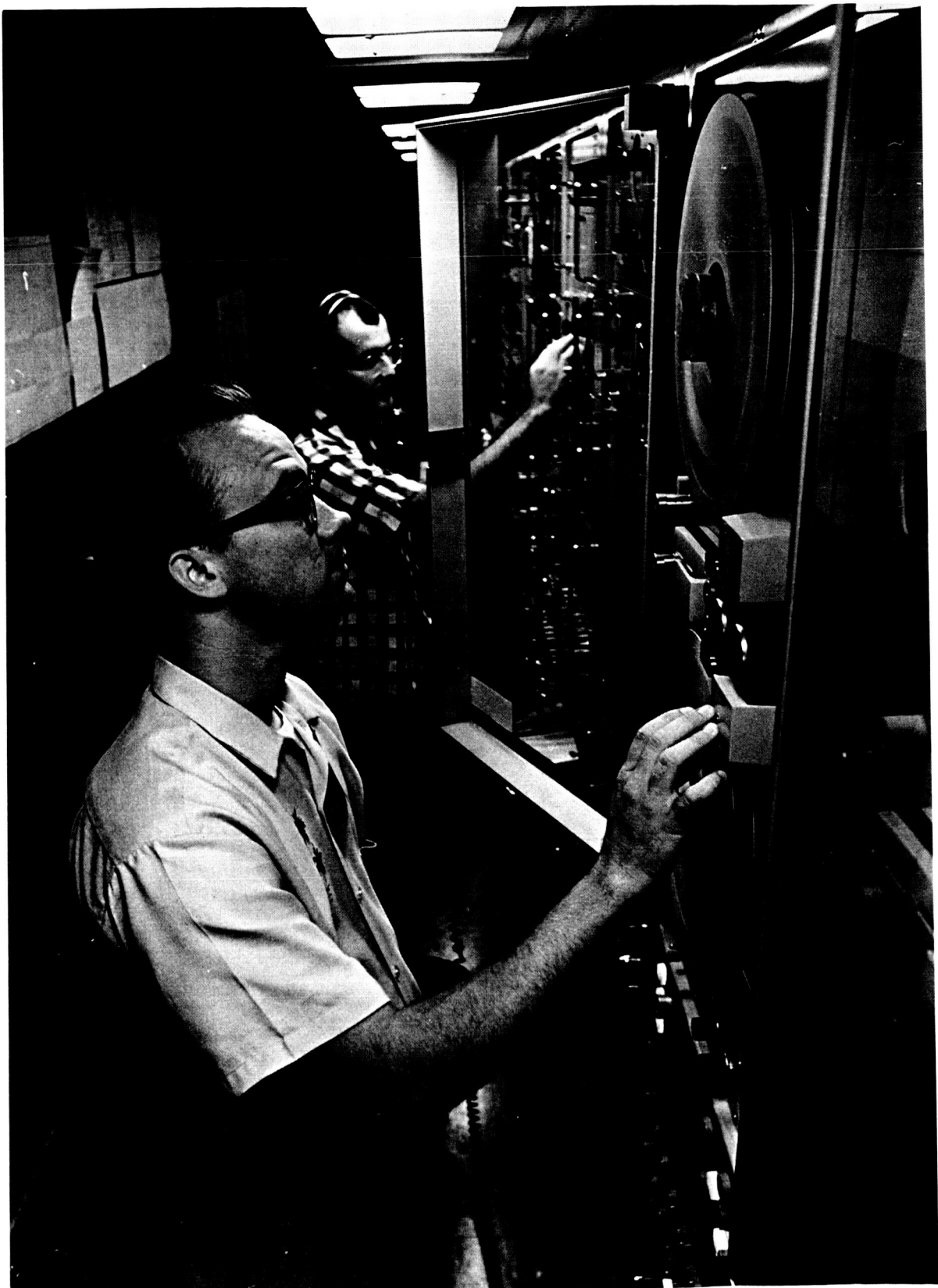


Fig. 15. DSIF-71 mission operations personnel

steady at -125 dbm until about 0300 when the signal gradually decreased to -131 dbm when Goldstone took over.

During the launch pass, telemetry was good until fade out of the horizon. The signal level was low and channels frequently went out of lock during the early part of the following pass, but as soon as the high-gain antenna was in use, the telemetry became clear and reliable. The only change in system parameters occurred at 162305 when the servo changed to narrow band. No unexpected significant events occurred.

c. DSIF-11, Goldstone Pioneer Station operations. During the launch phase of the *Ranger VI* Mission a normal countdown was conducted starting at 0900 on January 30, 1964 (see Fig. 16). The countdown was completed at 1436 and liftoff occurred at 154909. The launch phase was terminated at 1830 with all equipment left energized.

The countdown for the first tracking period was started at 2100. At 2344 the servo group reported the hour-angle high-speed valve was out of balance and would be replaced. Replacement of the valve was completed at 0005 on January 31. The remainder of the countdown was completed at 0305, with a final gain and bandwidth check being performed at 0515 to assure proper system functioning.

The spacecraft was acquired in two-way two-station noncoherent mode with a signal strength of -151 dbm at 055838, while the spacecraft was still below the horizon. The data system was started at 0559, taking one per min doppler samples. The antenna was switched to the slave mode of operation at 0600, and telemetry Channels 2, 3 and 6 discriminators were in lock at 0601.

Intermittent loss of lock was experienced during the transmitter changeover from DSIF-51 to DSIF-12 which started at 061846 and was completed at 062357. Signal level variations occurred throughout the midcourse maneuver, resulting in the receiver and all telemetry discriminators going out of lock between 084355 and 0844. An attempt was made to optimize the antenna position during the midcourse sequence at 0930, but the signal level, which was -127 dbm, was not improved. At 1557 during the changeover of transmitters from DSIF-12 to DSIF-41, the receiver was switched to a 60-cps bandwidth so that lock would be more easily attained. Momentary receiver and discriminator out of lock conditions were reported until 1611 when the receiver 20-cps bandwidth was restored. The signal level started decreasing as the antenna approached the horizon and optimizing of the

antenna position was started at 1658. The discriminators were out of lock at 1705, which was followed by the receiver dropping lock at 1707 with the spacecraft approximately 7 min below the local horizon.

The second tracking period countdown started at 0000 on February 1, and was completed at 0444 without encountering any system difficulties. At 0525 communications line No. 5 between the Pioneer and Echo stations became inoperative. The communications group was contacted immediately and service was restored at 0531. Acquisition of the spacecraft occurred at 060845 with the receiver immediately locking up in a two-way station coherent mode at a signal strength of -148 dbm. The telemetry discriminators were locked on at 1612, at a signal level of -139 dbm. Antenna slave mode tracking started at 161530, and continued normally at a signal level of -117 dbm. The teletype reperforator failed at 0745, repairs were made immediately, and it was back in operation at 0816. The CEC recorder failed at 170039. The transmitter changeover from Echo to Woomera was performed at 1715, and the system was switched to the two-way two-station noncoherent mode. Telemetry channels were out of lock at 172704, and the receiver went out of lock at 172726 ending the second pass tracking.

The countdown for the third tracking period started at 2330, with the CEC recorder which failed previously replaced with a spare unit. During the countdown, the 455-kc narrow-band and wide-band IF amplifiers were replaced when they exhibited an excessive gas condition. The remainder of the countdown was normal and was completed at 0456 on February 2, 1964.

Receiver acquisition occurred at 061055, in the two-way two-station coherent mode with a signal level of -153.5 dbm. The discriminators were locked in at 061345. The antenna switched to the slave mode of operation at 0617, and tracking was normal at a signal level of -118.5 dbm. Alternate switching of the receiver from good to bad data conditions started at 0759 as Echo was preparing to transmit commands, and continued until 081727 when Echo reported the synthesizer was in lock. At impact minus 93 sec, the Sanborn recorder was switched to high speed in order to get greater data resolution prior to impact. Signals ceased abruptly at 092433, when the *Ranger VI* spacecraft impacted the lunar surface. There were no unexpected significant events during the tracking mission.

d. DSIF-12, Goldstone Echo operations. The pre-launch countdown began at 0900 on February 30, and was completed at 1412, as shown in Fig. 17. The receiver clock

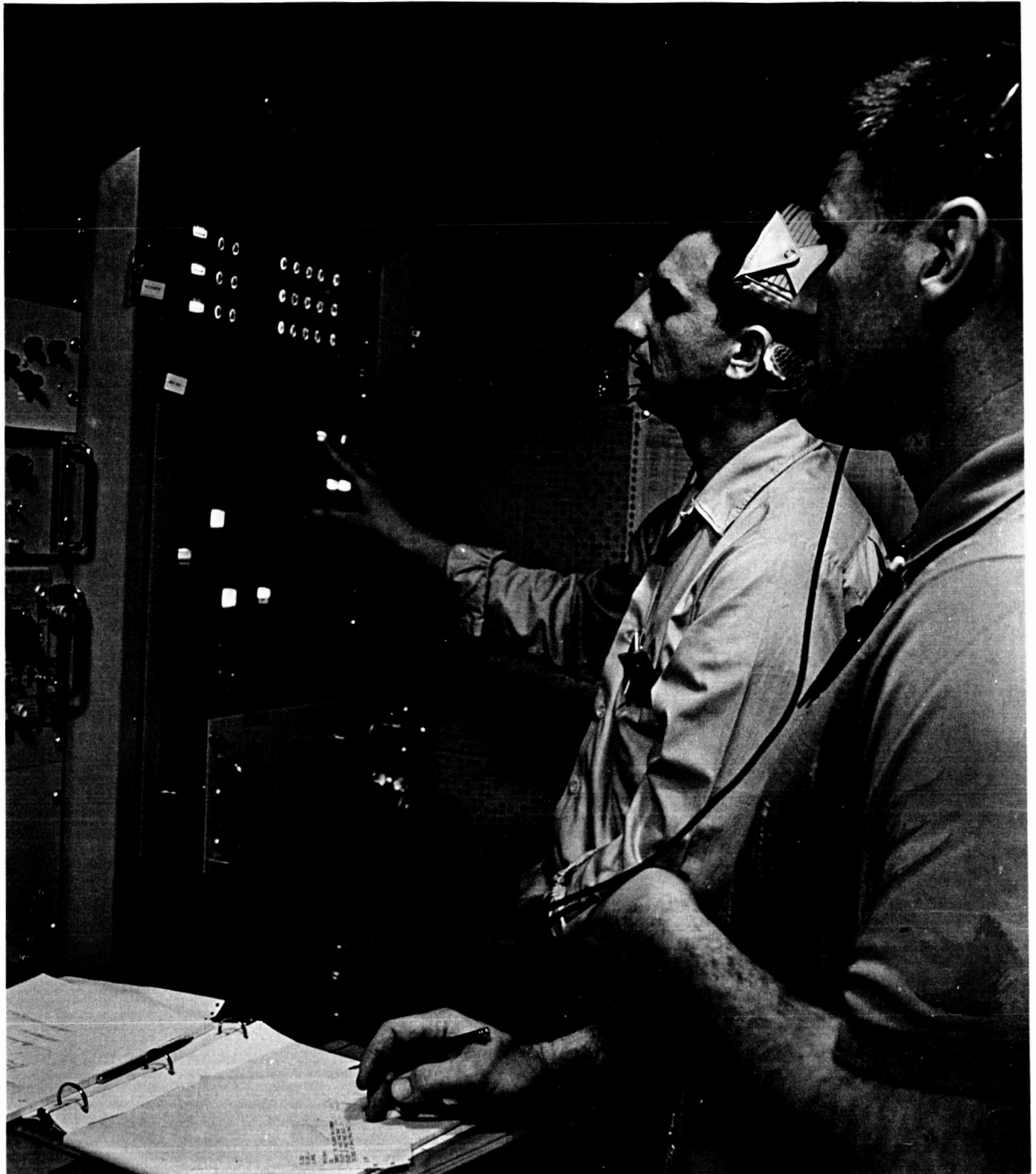


Fig. 16. DSIF Ranger VI countdown operations

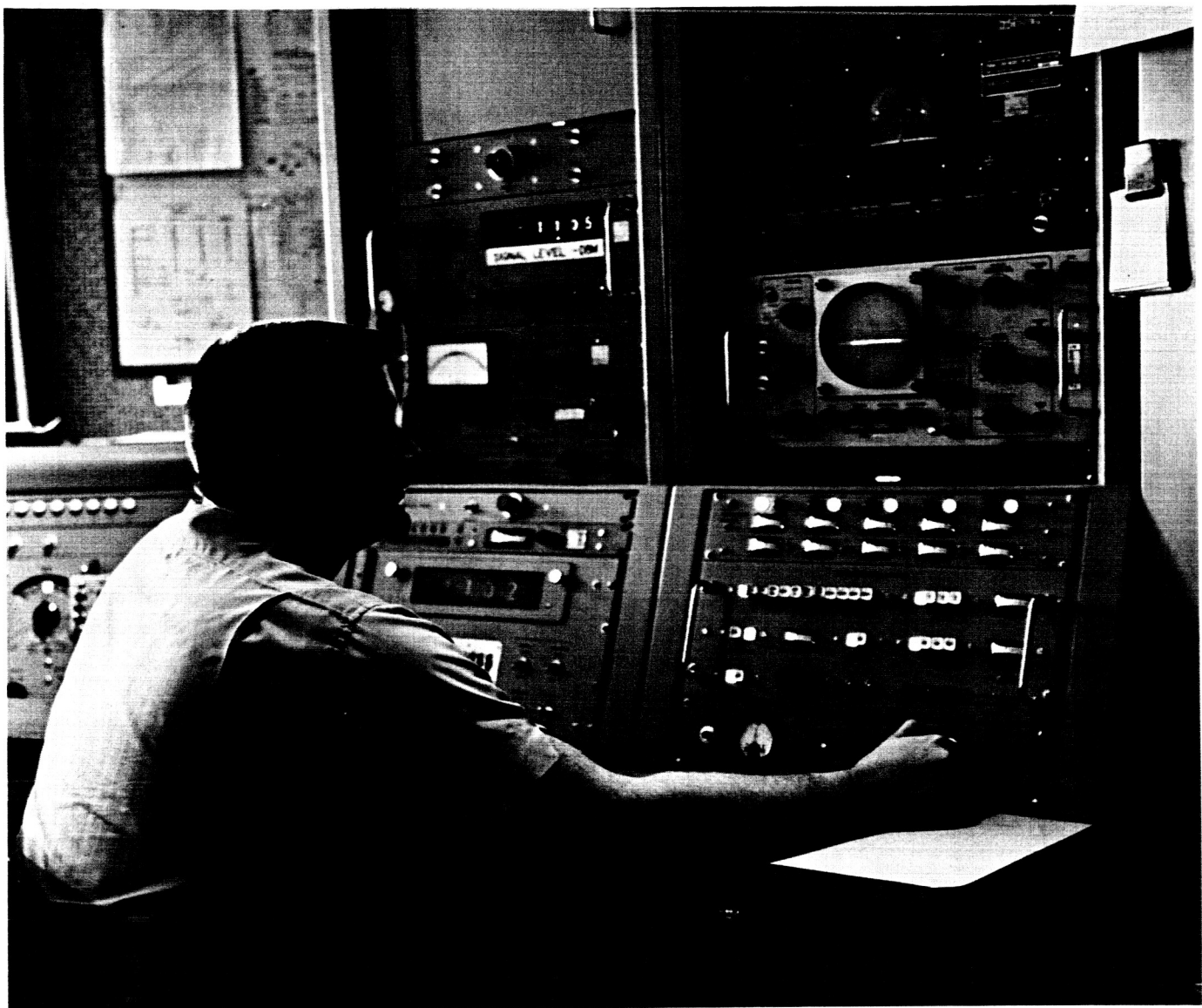


Fig. 17. DSIF-12 operations personnel

printer malfunctioned during countdown, but was repaired and re-installed at 1221.

Liftoff occurred at 154909 with the Echo station standing by with all systems go. At 161743 when Net Control announced the apparent turn on of the TV, the servo system was prepared for a high speed drive and personnel were alerted to stand by for a possible low-altitude pass. The announcement came from Net Control that the second *Agena* burn did not occur and the spacecraft was in lunar transfer at 163710. At 164552 it was advised that the transfer instructions were passed, and to prepare for the scheduled first pass in approximately 10 hr. At this

time, equipment was placed in standby, and communications terminated.

Countdown for the first tracking period began at 2030, and except for a discriminator failure and consequent replacement, the countdown was uneventful. Acquisition occurred at 053121 on January 31 with a signal level of -139 dbm. The receiver was switched to 20 cps bandwidth with a 10 sec time constant at 053255. The antenna servo was in slave at 0600, and two-way lock occurred at 62234 with a signal level of -133.5 dbm. Only minor equipment failures were experienced, and tracking to midcourse was normal. The midcourse maneuver began at 0720 with the

transmission of the first RTC-0 clear command preparing the spacecraft for later commands. The RTC-3 antenna switch-over command was sent at 0820 and the change was completed at 082325 with no loss of signal. The maneuver command RTC-4 was sent at 0830, and at 083645 Net Control announced the spacecraft roll was good. The final maneuver started at 0940 with two RTC-0 clear commands followed by the RTC-3 antenna change-over command at 0944. The midcourse maneuver had been successfully completed, with the receiver signal level holding steady at -110.5 dbm. The first pass switch-over began at 155651 and was completed at 170650 when the receiver went out of lock.

Countdown for the second pass began at 2300 and proceeded normally, with the antenna on point for acquisition at 0520, February 1. Acquisition in pseudo-two-way occurred at 053740, and two-way lock was accomplished at 060439. The second pass was a normal track, with all systems operating properly at a constant signal level of -115.8 dbm. The transmitter synthesizer momentarily lost sync near the end of the switchover. The receiver attempted to remain in lock for the duration of the track, but went out of lock at 172550. The transmitter was off at 177620, and the second pass was completed.

The third and final pass countdown began at 2300, and with all systems go, was completed at 052224 on February 2. Acquisition occurred at 0536 at a near threshold signal level of -160.4 dbm. Two-way lock was accomplished at 0600, and at 0612 the signal was -118.3 dbm, at which point it remained throughout the track. RCA began receiving Channel 8 telemetry (TV subsystem data) at 054640, and all systems were functioning normally.

Two RTC-0 clear commands were transmitted, one at 0810 and the other at 0812 with each being verified 39 sec after transmission. At this time all systems were seemingly normal and in readiness for the TV warmup command RTC-7 which was transmitted at 0908 and verified 39 sec later. The TV power supply voltage, as determined from telemetry data, did not indicate that the TV subsystem was on full power. Two additional RTC-7 commands were sent at 091529 and 091921 in what proved to be a futile attempt to turn on the TV subsystem. No video was received, for the TV subsystem apparently stayed in the warmup mode until impact on the lunar surface at 092433. Antenna coordinates at impact were DEC 001402; HA 326644.

e. DSIF-41, Woomera operations. Countdown for the first pass started at 0800 on January 30, 1964 and was

completed without difficulty (see Fig. 18). Word was received that the TV cameras may have turned on inadvertently, and a check of Channel 8 (TV subsystem disposition) telemetry was requested upon acquisition.

Approximately 10 min prior to *Ranger VI* initial acquisition, the antenna was on point, data sampling was commenced, and the telemetry recorders were turned on. Acquisition through ack aid and pseudo-two-way occurred at 163353, and at 163628 the signal was received through the 85-ft dish; but due to operator error, transfer from the ack aid antenna did not occur. It was reported to Net Control at 163637 that all indications from telemetry Channel 8 (TV subsystem disposition) tended to bear out that the video system was functioning properly. With the antenna in the autotrack mode, the transfer from the ack aid to the main antenna was made at 163950. Upon antenna transfer, the signal level increased from -120 to -95 dbm, and all TM channels were in lock, although Channel 4 was noisy on the high-frequency excursions. At 1644 two-way lock was confirmed and tracking was normal. At 1650 and 165530 event blips indicated the solar panels extended, and Sun acquisition was completed. The Earth acquisition sequence started at 1920 and was completed at 1945. An RTC-0 clear command starting the antenna changeover sequence was transmitted at 202540, but was cancelled because of marginal transmitter power and the responsibility given to DSIF-51.

The antenna changeover from the omni to the hi-gain antenna was verified by an event blip (B-20) and by the increase in signal strength at 2114. Tracking continued normal until loss of lock at 235117, terminating the first tracking period.

Prior to the second pass, the RF configuration was changed to permit the transmitter to radiate through the 85-ft dish and by-pass all relays associated with the ack aid. During this change, a fault developed with the parametric amplifier and connecting coaxial lines. The fault had not been corrected by the time countdown was started, so the paramp was by-passed and the spare cage-mounted paramp put into service.

The spacecraft was acquired in pseudo two-way lock at 1225 on January 31 even though the transmitter was 3 kc off frequency. Angle channel phasing, which time would not allow during countdown, was started at 1228 and completed with the servo in slave at 123311. Because of erroneous data, at 125035, Net Control requested that spacecraft tracking be abandoned and a complete AGC

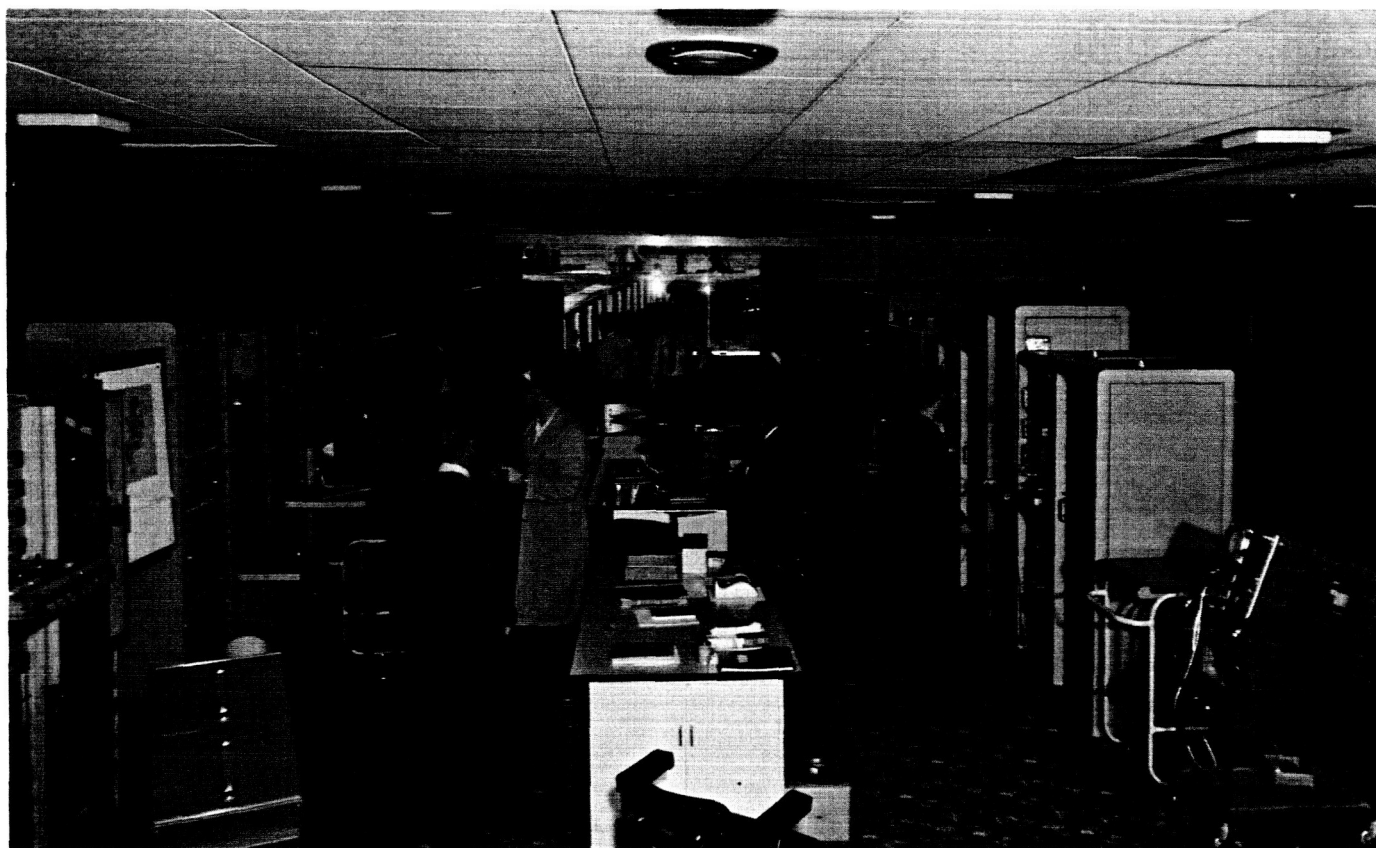


Fig. 18. DSIF-41 operations personnel

calibration be performed. At 131447 the AGC calibration was completed and the spacecraft reacquired in pseudo two-way lock. There was evidence of hour angle oscillations at 1336, at which time the signal level was -113 dbm. While preparing for two-way acquisition the receiver momentarily lost lock at 1540. The 200-w transmitter was on at 1601, but due to an operator error in reading one-way, instead of two-way doppler mixer output, the transmitter frequency was off. The receiver was out of lock for 18 sec prior to two-way lock at 160216. Tracking was normal, at a signal level of -115 dbm, until all communications were disrupted at 191836. The disruption was caused by a tree falling across and cutting the aerial land line between Adelaide and Port Augusta during a severe storm. The teletype circuits were back in operation at 1926, and voice communications were restored a short time later through a patch via Gowler. Tracking proceeded, with momentary receiver loss of lock being experienced during the remainder of the mission. Hour angle oscillation was again in evidence at 2117, with excessive oscillation being experienced at 0007 on February 1. When DSIF-51 started interrogating the spacecraft at 2150 an increase in the dynamic phase error was

observed, which was found to be caused by an extra pair of sidebands (103.5 cps) on either side of the carrier. The servo went into prelimit and tracking was concluded at 0033 on February 1.

The countdown for the third and final tracking period was uneventful, and proceeded normally. The spacecraft was acquired in pseudo two-way lock at 124610 on February 1. Tracking continued normal at an average signal level of -117.5 dbm until 2020 when the major equipment failure for the mission occurred. At this time the transmitter VCO went unstable and the doppler bias loop went into a permanent false lock. Net Control advised that TM data was of prime importance and it was essential therefore not to knock the main loop out of lock in order to change over to a spare VCO or to Johannesburg. There was no good two-way doppler for the remainder of the mission because of the unstable VCO, and forthcoming Precision Doppler Bias Loop (PDBL) failure. At 2142 the transmitter VCO became stable, but the PDBL jumped to the false lock position and failed to respond to attempts to relock. Again Net Control advised not to break lock because of the importance of TM data. TM

reception continued for the remainder of the mission. At 235035 a gradual increase in the dynamic phase error and the reappearance of spurious sidebands were observed. The spurious sidebands first appeared at 2150 on the second pass; however, this time they were 83.4 cps away from the carrier where previously they were 103.5 cps away. After a discussion with Net Control and Johannesburg it was established that the sidebands were associated with the Johannesburg transmitter. Tracking continued at a signal level of -119.6 dbm until 0039 on February 2, when the receiver went out of lock concluding the *Ranger VI* tracking mission.

f. DSIF-51, Johannesburg operations. Countdown for the *Ranger VI* mission started at 0705 on January 30. The countdown, which was normal, except for minor problems with the transmitter and CEC recorder, was completed at 1534, as shown in Fig. 19. Lift-off occurred at 154908, the transmitter was turned on at 161833, and the receiver was in one-way lock at 161944 at a signal level of -89.2 dbm. There was no sign of a video signal from the spacecraft, and servo went to autotrack 5 sec after acquisition. Two-way lock was achieved at 162053. At 163632, servo was at prelimits and the receiver lost lock at 1642, thus completing the launch pass.

Prior to the first pass, with the spacecraft still below the horizon, raw telemetry data were fed by land-line from DSIF-59 which was already in lock with the spacecraft. The discriminators were locked up on this data until 1850, at which time DSIF-51 locked up on its own data, having acquired the spacecraft in pseudo-two-way at 184334. The transmitter was switched on at 190857 and two-way lock was obtained at 190924. The transmitter was switched off at 2000 and at 200243 pseudo two-way lock was confirmed. At 203606 the transmitter was again switched on preparatory to sending commands. Two-way lock was achieved at 203618, and the receiver bandwidth switched to 20 cps at 204717. The first RTC-0 clear command was initiated at 210800, followed by the second RTC-0 2 min later. The RTC-3 antenna changeover command was initiated at 2112, with verification in the form of a B-20 blip coming at 211240. The receiver signal level rose to -107 dbm at 211310. The spacecraft was tracked for the next 9 hr. The receiver dropped lock momentarily approximately 20 times during this period, apparently due to interface problems between transmitter and receiver. At 0506 trouble with the CEC recorder developed, and at 0515 it tripped out and was removed for repair. The transmitter power was reduced at 0609 in preparation for spacecraft transfer to Goldstone. At 0630 the trans-

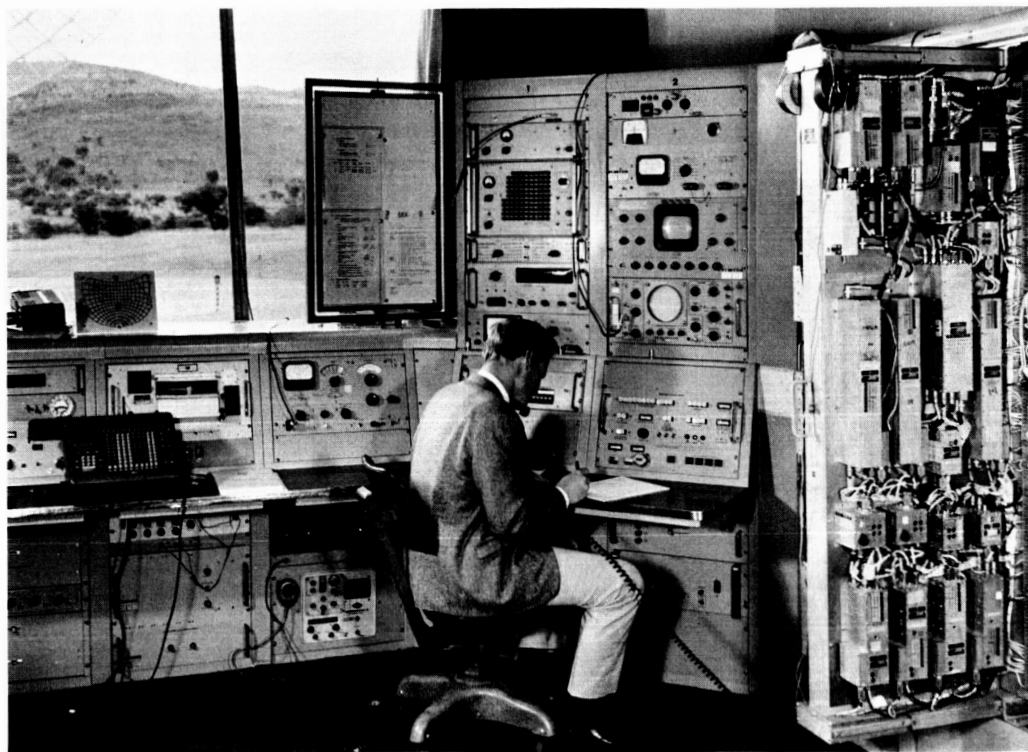


Fig. 19. DSIF-51 operations personnel

mitter was switched off, and the spacecraft reacquired in pseudo-two-way lock at 063030. The receiver signal was steady at -111.2 dbm until the spacecraft set below the horizon and lock was lost at 073051.

The countdown for the second pass started at 1300 on January 31 and was completed at 1820. Acquisition in pseudo two-way occurred at 201220 at a signal level of -135 dbm. No video signals were apparent and the signal level was -118.5 dbm at 201930. Two-way lock was accomplished at 2105, and tracking continued in this mode for the next 9 hr. The receiver, as on the first pass, experienced momentary out-of-lock at various intervals. Spacecraft transfer to Goldstone was completed by 062026 on February 1 when pseudo-two-way lock was achieved. Tracking continued until 075104 when the spacecraft went below the horizon.

Countdown for the third and final pass began at 1300 on February 1 and was completed at 1800. The spacecraft was acquired in pseudo-two-way at 202723 with tracking in this mode continuing normally except for a momentary loss of lock due to a frequency change at DSIF-41. At 234630 two-way lock occurred with a -115 dbm signal level being recorded. The transmitter was turned off at 0039 on February 2 to change the VCO which was apparently producing a spurious modulation on the trans-

mitted carrier frequency. The receiver was in the one-way mode from 003920 to 004012 when the transmitter was switched on with two-way lock being confirmed 3 sec later. Two-way lock was again interrupted for a 15 min period when the transmitter was turned off at 030016. The transmitter started reducing power at 0557 in preparation for spacecraft transfer to Goldstone. The transfer was effected smoothly, the transmitter being turned off at 060134 and the receiver going to the pseudo-two-way mode without loss of lock. The receiver went out of lock for the last time at 075337 as the spacecraft set below the horizon completing the *Ranger VI* tracking mission.

F. Performance Evaluation

In general, the quality of the tracking data received from the DSIF stations was excellent, although there were some problems. A summary of the tracking data used in the Orbit Determination Program (ODP), together with the noise statistics, is presented in Table 7.

1. Angular Data

The angular data show that the correction polynomials used in the ODP to describe the angular pointing error were not adequate. Large biases remain in the hour angle residuals after these corrections have been applied. A

Table 7. Summary of DSIF tracking data used by ODP in *Ranger VI* spacecraft orbit computations

DSIF station	Data type	Beginning date/GMT	Ending date/GMT	Number of points	Standard deviation	Root mean square (rms)
PRE-MIDCOURSE						
Echo	C _c 3	21/0635	31/0646	31	0.0229 cps	0.0542 cps
Woomera	C _c 3	30/1659	30/2034	136	0.0259 cps	0.0283 cps
	HA	30/1647	30/2301	340	0.0139 deg	0.0373 deg
	Dec	30/1647	30/2301	342	0.0072 deg	0.0210 deg
Johannesburg	HA	30/1621	30/1630	108	0.0027 deg	0.0521 deg
	Dec	30/1621	30/1630	108	0.0028 deg	0.0231 deg
	C _c 3	30/1626	31/0620	485	0.0361 cps	0.0374 cps
	HA	30/1915	31/0633	577	0.0143 deg	0.0244 deg
	Dec	30/1915	31/0633	576	0.0105 deg	0.0109 deg
POST-MIDCOURSE						
Pioneer	C _c 3	31/0907	31/1600	396	0.0237 cps	0.0237 cps
	C _c 3	01/0742	01/1728	571	0.0146 cps	0.0154 cps
Echo	C _c 3	31/0906	31/1600	384	0.0146 cps	0.0152 cps
	C _c 3	01/0612	01/1724	665	0.0146 cps	0.0146 cps
Woomera	C _c 3	31/1608	31/2103	230	0.0310 cps	0.0317 cps
	C _c 3	01/1736	01/2038	161	0.0587 cps	0.0611 cps
Johannesburg	C _c 3	31/2106	01/0555	397	0.0310 cps	0.0310 cps
	C _c 3	01/2355	02/0154	100	0.0467 cps	0.0468 cps

better set of correction coefficients or a better method of antenna calibration is needed.

2. Doppler Tracking Data

The doppler tracking data were excellent except for the first pass at Johannesburg and the latter part of the third pass at Woomera. The doppler data from the MTS were unusable in the ODP because the computer was recycling at odd times. Almost all doppler data for the Johannesburg first pass were lost due to poor station performance. The ODP was able to use only 40 of the 244 points of 5-sec sample data taken at Johannesburg on the first pass. A total of 3½ hr of doppler data were lost during the Woomera third pass because of transmitter VCO instability and the precision bias doppler loop showing a false lock condition. The quality of the doppler data from both Goldstone stations was excellent throughout the mission. A reduction in doppler noise on this mission in comparison to previous missions was obtained by using the frequency synthesizer rather than the VCO, which may be seen by comparing the noise statistics of Echo data (Table II-3) on January 31 with those of February 1.

3. Transfer Procedure

A new transfer procedure, which consisted of transferring the spacecraft from one station to the other without going to the one-way doppler mode, was successfully effected several times without loss of ground station lock. Some data were lost however, due to the incorrect use of the data conditioning code. In several instances the two stations involved in the transfer reported good one-station two-way doppler for simultaneous periods.

4. Equipment Problems

The following equipment problems were encountered during the *Ranger VI* mission.

a. DSIF-59, Mobile Tracking Station. The only serious failures occurred during countdown; these were (1) the failure of a voltage regulator diode, causing a 3-min power outage, and (2) the failure of the collimation tower polarization drive, causing a slight delay in countdown. During operations, 2 min of tracking data were lost due to corrosion of the card contacts on the doppler shift register cage causing the tape punch to run away. Lack of communication circuits delayed much of the information obtained by this station; at one stage, twenty tapes were waiting to be transmitted, including valuable Channel 8 data.

b. DSIF-11, Goldstone Pioneer Station. There were no equipment problems during the first tracking period of

the *Ranger VI*. During the second pass at 0745 on February 1, the reperforator unit failed as a result of a defective relay, repairs were made and the unit was back in operation at 0816. Occasional bad samples in the data subsystem were caused by dirt in the transmitter/distributor. The dirt accumulates in the transmitter/distributor when tape from the high speed punch is run onto the floor to store it for simultaneous transmission. Near the end of the second tracking period, the CEC recorder failed and was replaced with a spare unit prior to the third pass. Some difficulty was encountered before the third tracking period due to a last minute requirement for recording spin modulation in both oscillographs and the Ampex recorders. The equipment had to be set up at the same time as the replacement CEC oscillograph was being aligned. The maser/paramp subsystem operated normally, with no failures or unusual occurrences observed. The receiver subsystem operated normally during the entire mission. The servo system encountered some difficulty with "bad commands" received from the coordinate converter. The same servo problem was encountered during Compatibility Test No. 3.

c. DSIF-12, Goldstone Echo Station. During the first pass on January 30, there was a decommutator malfunction with address 30 data condition indicator sending good data continuously. The failure was found to be in the B-19 discriminator, which was replaced. Later, a Channel B-20 discriminator failed and was replaced. A TTY punch was replaced to correct a garbling of data lines, and a bad DC amplifier in the 2G-2C line was replaced.

On the second pass, the only failure was a TTY reperforator which was repaired and reinstalled.

Prior to countdown for the third pass, the parametric amplifier failed. A new klystron was installed and tuned during countdown. All system operated in a satisfactory manner during the entire mission.

d. DSIF-41, Woomera Station. The Channel 4 discriminator output was noisy and off the scale on the high frequency end during the first pass. Since useable data were being received, the station was requested not to change the discriminator. The discriminator was replaced after the first pass and no further trouble was experienced.

When the station changed to the second pass RF configuration, the parametric amplifier showed low maximum gain and had a tendency to oscillate. For this reason, the cage-mounted paramp was used for the remainder of the track.

At 2020 on the third pass the transmitter VCO started to drift and later showed jumps of up to 18 cps. In view of the importance of telemetry data, two-way lock was not broken to replace the VCO. This condition persisted until 2145 when the VCO apparently became stable. The apparent reason for the instability was an unsoldered lead inside the module between the input and the 29%-Mc distribution amplifier. At 2142 on the third pass the PDBL went into a false lock condition which could not be corrected. This condition was allowed to persist because of the importance of telemetry data. A post mission check disclosed the X 90 module was outside specifications and the 30 + 1 module contained an intermittent coaxial connector. Two digits on the telemetry digital printer gave an occasional random incorrect printout in the last few hours of the mission. Mechanical adjustment and the relay driver cards in the print mechanism were the apparent cause for the random printout.

e. DSIF-51, Johannesburg Station. There were very few equipment faults during the mission, and those that occurred were rectified rapidly.

The CEC recorder was out of action for the latter part of the first pass on January 31 as a result of a lamp failure. A card in the Beckman decommutator, which had caused faulty rate 4 readouts, was replaced after the first track. Although the Ransome decommutator was not used, several cards were replaced during countdowns to keep it operational.

No faults occurred with the receiver, although it did drop lock on a number of occasions for no apparent reason. These dropouts, most of which were of very short duration, only occurred when the station was in two-way lock, thus the transmitter VCO which was replaced later was in all probability the cause.

There were no servo problems during tracking, but due to a fault in the gear train, the hour angle follow-up package was replaced during a countdown when the counters failed to follow.

The acquisition panel which had been used for *Mariner* missions was installed prior to the third pass to facilitate finer adjustment of transmitter VCO frequency. While in two-way lock on the second pass, the transmitter was kicked off by a safety switch in the klystron body current circuit. It was restarted and operated satisfactorily for the remainder of the mission. During the third pass, while in two-way lock, an 80-cycle modulation was observed on the receiver dynamic phase error signal. This spurious modulation was traced to a faulty transmitter VCO,

which was replaced, and the problem cured. The receiver dropout could also have been caused by this faulty VCO.

G. Participation of Non-DSIF Agencies

1. Space Flight Operations Center

All spacecraft command and monitor functions took place in the Space Flight Operations Center at JPL, where spacecraft data were analyzed, evaluated, and interpreted. Additional support was provided by the Central Computing Facility, which reduced all *Ranger VI* tracking and telemetry data to usable form. Communications were controlled by the Communications Center, which handled all communications circuits providing data flow to or from any DSIF station or operational unit at JPL.

2. Atlantic Missile Range (AMR)

The AMR was assigned the responsibility of providing JPL with orbital elements of the parking and transfer orbits; acquiring information for DSIF-41, -51, and -59; and supplying the raw data that would be used by JPL to provide a back-up to the computations of the transfer orbit.

There were 30 engineering sequential cameras set up for optical coverage of this test, with 28 producing usable photography. The IGOR at Grand Bahama Island and the Mobile Instrumentation Telescope Tracking System at Vero Beach were not started because cloud cover prevented visual acquisition.

The AMR network for this mission consisted of the following stations: MK II Azusa, Tel II, Tel III (all located at Cape Kennedy); Grand Bahama Island, San Salvador, Bermuda, Antigua, Ascension, Pretoria; and the ships ORV 1851 (Whiskey), ORV 1886 (Uniform), and ORV 1852 (Yankee). Tracking facilities of the AMR supporting *Ranger* are presented in Fig. 20.

The first track was that of the *Atlas* booster by the MK II Azusa from T plus 4 to T plus 376 sec. The uprange stations tracked the *Agena* C-band radar with overlapping coverage from T plus 50 to T plus 730 sec. The downrange C-band radar, with only short lapses between stations because of their displacement and the small elevation angle, provided coverage from T plus 954 to T plus 3630 sec. The launch trajectory was such that the *Agena's* highest elevation angle at Ascension was 3.5 deg.

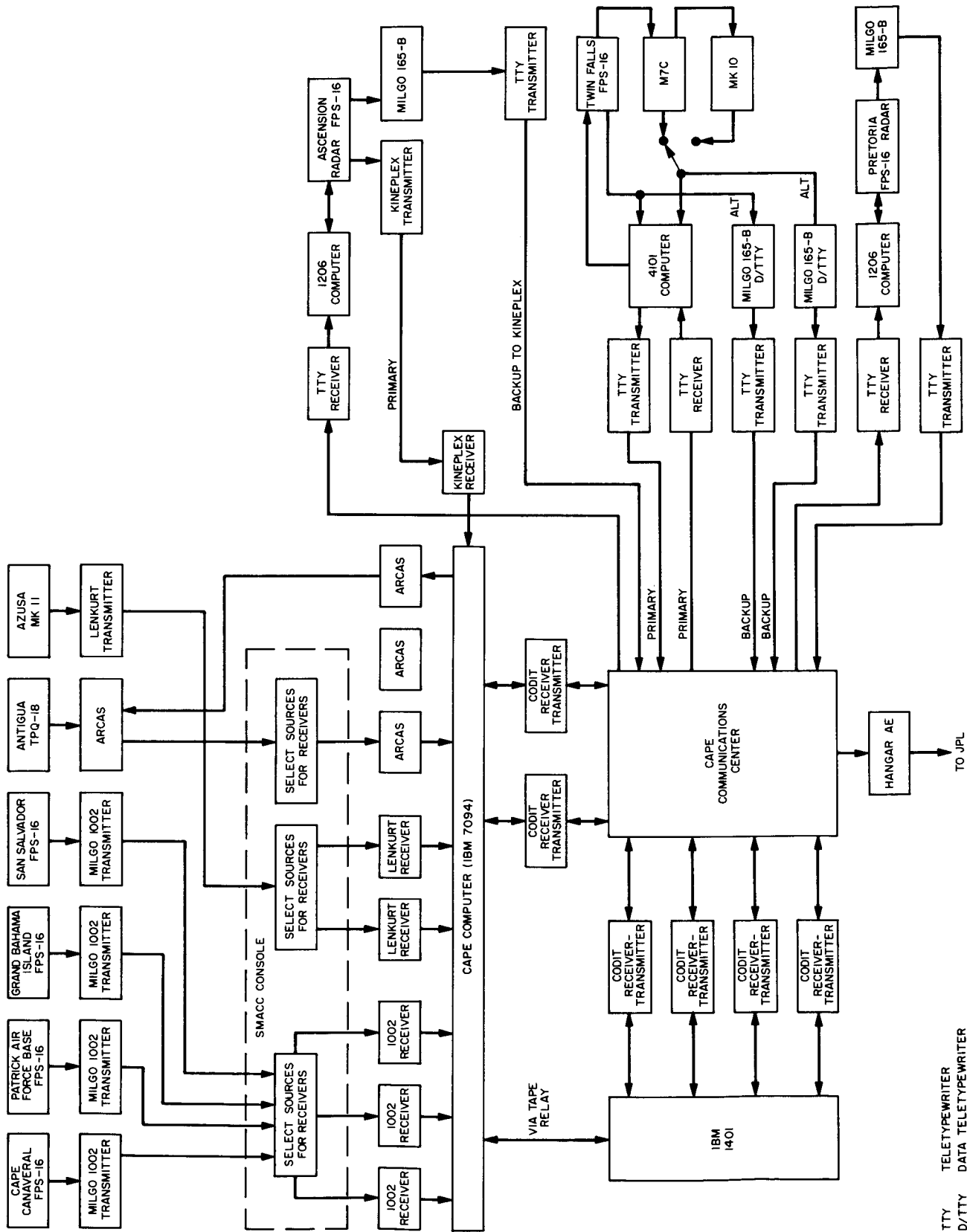


Fig. 20. Tracking facilities supporting Ranger at AFETR

The AMR provided continuous and overlapping coverage of the *Atlas*, *Agena*, and spacecraft telemetry. The *Atlas* link coverage was from T minus 420 to T plus 735 sec, with all discretes being confirmed at Cape Tel II in real time. *Agena* telemetry coverage began at T minus 420 sec, and was discontinued at T plus 4420 sec. The *Agena* telemetry data were played back up the subcable from Antigua in post-test time.

The 960-Mc spacecraft telemetry coverage started at T minus 420 sec, and continued to T plus 4420 sec. A new

procedure for expediting delivery to JPL of telemetry recorded by the AMR downrange stations was used on the *Ranger VI* mission. This procedure consisted of having each station play back the recorded output of its 960-Mc receiver and transmit the signal to Tel II where it was recorded. The retransmission from Antigua, via subcable, produced a fairly good record. The data from Uniform, Ascension, Yankee, and Pretoria were retransmitted via single sideband radio, and the resultant records were so noisy that they were of little value, because there was not a time code signal present to help identify the data.

Table 8. *Ranger VI* telemetry coverage

Station	Period coverage	Type coverage	Reduction status
DSIF-71 AMR-1/Tel II	January 30 1542-1557 1542-1557	960 Mc 244.3 Mc 960 Retrans from ANTIGUA 960 Retrans from UNIFORM 960 Retrans from ASCENS. 960 Retrans from YANKEE 960 Retrans from PRETORIA	TPS various analogs, digitized TPS environmental data analog DRL spacecraft data analog TPS analogs (Better records available) (No time on tapes)
AMR-1/Tel III AMR-3 (GBI) AMR-5 (SAN SALV) AMR-91 (ANTIGUA)	1542-1557 1550-1558 155.1-1559 1555-1602	960 Mc 244.3 Mc 244.3 Mc 244.3 Mc 960 Mc	TPS analog None None TPS environmental data analog TPS analog, digital
ORV-1851 WHISKEY ORV-1886 UNIFORM	1601-1607 1601-1608	244.3 Mc 244.3 Mc 260 Mc	Analog None TPS analog, digital
AMR-12 ASCENSION	1609-1613	244.3 Mc 960 Mc	None TPS analog, digital
ORV-1852 YANKEE	1613-1620 1615-1621	244.3 Mc 960 Mc	TPS analog TPS analog, bad time
AMR-13 PRETORIA	1625-1647	960 Mc 244.3 Mc, 3 tapes	TPS analog, bad time No spacecraft data
DSIF-59 (MTS) DSIF-51 JOBURG DSIF-41 WOOMERA	1620-1649 1625- 1635-	1st, 2nd pass, 4 tapes 1st, 2nd pass, 4 tapes 1st pass, 2 tapes	TPS analog, bad time code TPS analog, digital TPS analog, digital
DSIF-12 GOLDSTONE DSIF-11 GOLDSTONE DSIF-41 DSIF-51	January 31 0525- 0559 1950	1st pass, 3 tapes 1st pass, 3 tapes 2nd pass 3rd pass	TPS analog, digital No tapes
DSIF-12 DSIF-11 DSIF-41 DSIF-51	February 1 0533- 0608-	2nd pass, 3 tapes 2nd pass, 3 tapes 3rd pass 3rd pass	No tapes No tapes
DSIF-12 DSIF-11	February 2 0530- 0611-	3rd pass, 2 tapes 3rd pass, 1 tape	TPS analog, digital
TPS Telemetry Processing Station			

The Cape Computer Facility used data from Azusa MK II for real time range safety Impact Prediction up to *Atlas/Agena* separation. San Salvador radar was then the prime data source for Impact Prediction until the vehicle reached orbital velocity. Parking orbit computations of orbital parameters and DSIF look angles were made using

data from Antigua. Transfer orbit computations were made based on data from Pretoria radar. Transmissions from the Cape Computer Facility to JPL were then made in near-real time. A summary of telemetry coverage provided for *Ranger VI* along with data reduction status is presented in Table 8.

III. RANGER VII MISSION

A. Flight Plan

The *Ranger VII* mission was the fifth flight of the Project aimed at lunar impact. The primary scientific objective of this *Block III* flight was to obtain high-resolution television pictures of the lunar surface. Basic engineering objectives of the mission were identical to those of *Ranger VI* and were concerned with the following experiments:

1. Trajectory correction (midcourse maneuver)
2. Terminal attitude maneuver
3. Further development of basic spacecraft technology through performance evaluation of the *Ranger* Spacecraft.

The *Ranger VII* spacecraft (Fig. 21), except for minor changes to the TV subsystem, was identical to *Ranger VI*. The TV subsystem was composed of 6 one-in., slow-scan video cameras divided into two separate equipment chains for increased reliability. The two chains, while essentially similar, contained different camera configurations. The (F) or full-scan chain contained two cameras having four hundred optical line pairs and the (P) or partial-scan chains contained four cameras having one-hundred optical line pairs. Each chain of cameras was exposed and read out in sequence; both chains operating simultaneously to modulate the spacecraft FM transmission to the DSIF receiving stations. The subsystem was designed to provide a resolution of 0.5 to 5 m in the final picture.

The flight plan for *Ranger VII* is illustrated in Fig. 22, 23, and 24. The thermal shroud is ejected after sustainer burn out. At the conclusion of the first *Agena* burn, the *Agena*/spacecraft is placed into a coasting or parking orbit. The second ignition and burn of the *Agena* injects

the combined *Agena*/spacecraft into a lunar transfer trajectory. Immediately after injection, the spacecraft is separated from the *Agena* stage.

The spacecraft Sun and Earth acquisition sequence is initiated after separation, attitude control system activation, solar panel erection, and high-gain antenna rotation to a present hinge angle. Solar sensors controlling the attitude control jets cause the spacecraft to point its roll axis toward the Sun, thereby placing the solar cell power system in operation. The spacecraft then turns about its roll axis until the antenna beam lies in the plane defined by the spacecraft roll axis and the Earth. While maintaining the antenna beam in this plane, the Earth sensors command the antenna to move so that its propagation axis intersects the Earth, establishing the high-gain communication link. The spacecraft then continues to coast in the attitude of solar and Earth acquisition.

Following a suitable tracking period, the required trajectory corrections are computed and the corrective maneuver commands transmitted to the spacecraft. The resulting midcourse maneuver turns the spacecraft through the prescribed angles, supplying the necessary thrust correction, and returning the spacecraft to its Sun and Earth orientation. Upon approaching the lunar surface, commands are initiated from Earth and the terminal maneuver is performed to align the cameras for the television picture sequence. The TV subsystem is turned on by a command from the spacecraft at approximately 15 min prior to impact and a backup command for the turn-on is also sent from the DSIF. At 13 min 30 sec before impact, the TV subsystem begins taking and transmitting pictures from both the wide-angle and the narrow-angle cameras. The picture sequence begins at a nominal attitude of 1400 km, and continues until the spacecraft-television subsystem combination impacts the lunar surface, completing the mission.

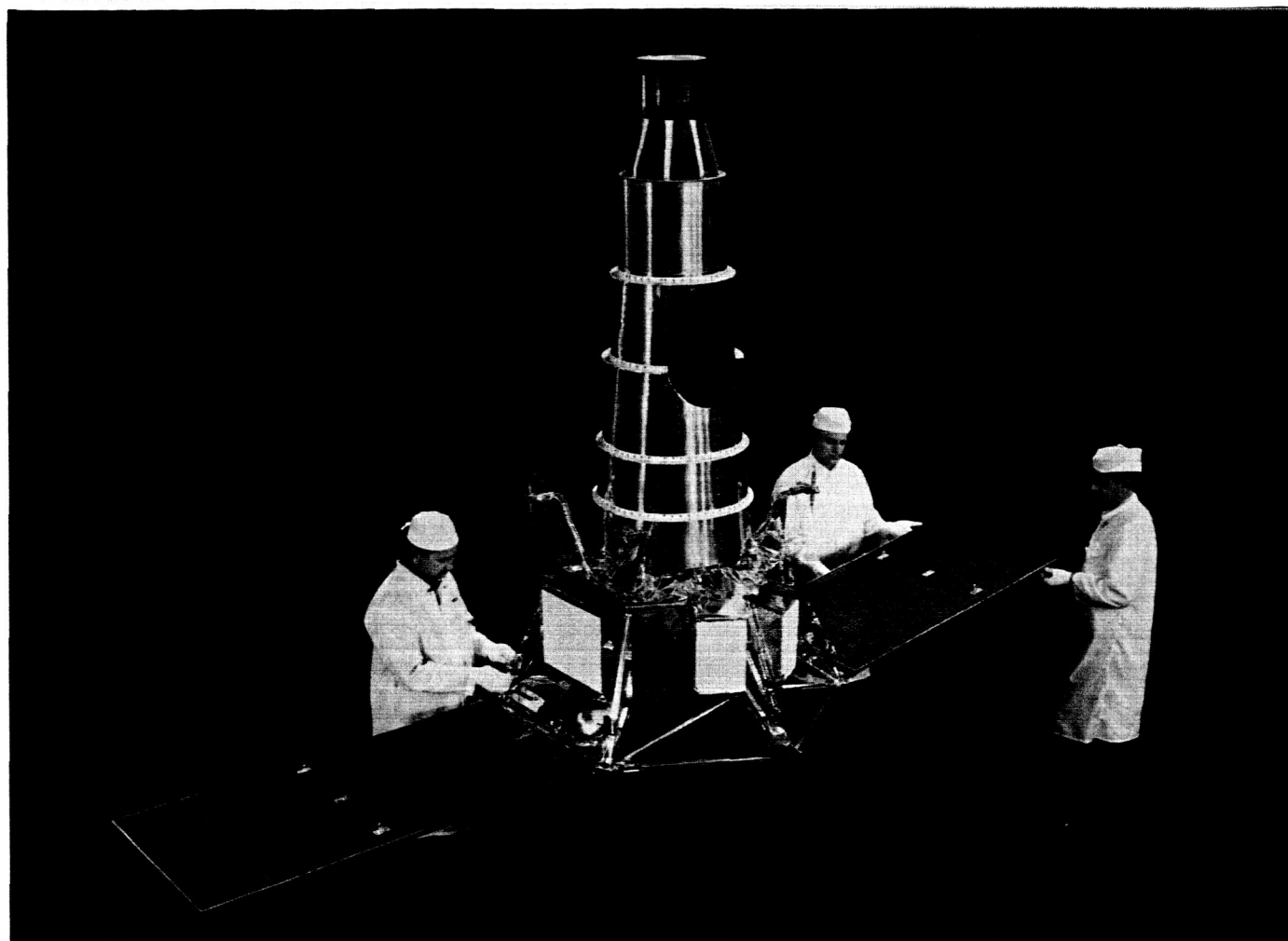


Fig. 21. Ranger VII spacecraft

B. Mission Synopsis

The first *Ranger VII* launch attempt on July 27, 1964 was initiated at 0847 (T-395 min), and was cancelled due to the failure of the *Atlas* telemetry battery and evidence of excessive noise in the ground guidance system. These problems were not resolved in time to permit launch during the available launch window.

The second *Ranger VII* launch attempt on July 28, 1964, was successful with lift-off occurring at 165008. The Spacecraft Monitoring Station at Cape Kennedy (DSIF-71) was in two-way lock with the spacecraft at launch, but lost lock 30 sec after lift-off. Receiver lock was re-established a few seconds later on a sideband and was maintained throughout the remainder of the station's view period. Due to the sideband lock, the telemetry received at DSIF-71 during this view period was marginal. The

Atlas and *Agena* vehicles performed within their tolerances and injected the spacecraft on its lunar intercept trajectory, within injection occurring at 172001.

Because of its trajectory, the spacecraft was not tracked by the DSIF until 172050 when it was acquired by the Mobile Tracking Station (DSIF-59) in two-way lock. The next station to acquire spacecraft was Johannesburg (DSIF-51) with intermittent one-way lock at 172138. The Woomera station (DSIF-41) acquired the spacecraft in two-way lock at 173850. Continuous surveillance of the spacecraft began 20 min after initial acquisition by DSIF-41. Subsequent tracking periods are summarized in Table 9.

The normal spacecraft events observed by DSIF-41 included solar panel extension, solar acquisition, and Earth acquisition. The first ground commands (RTC-3)

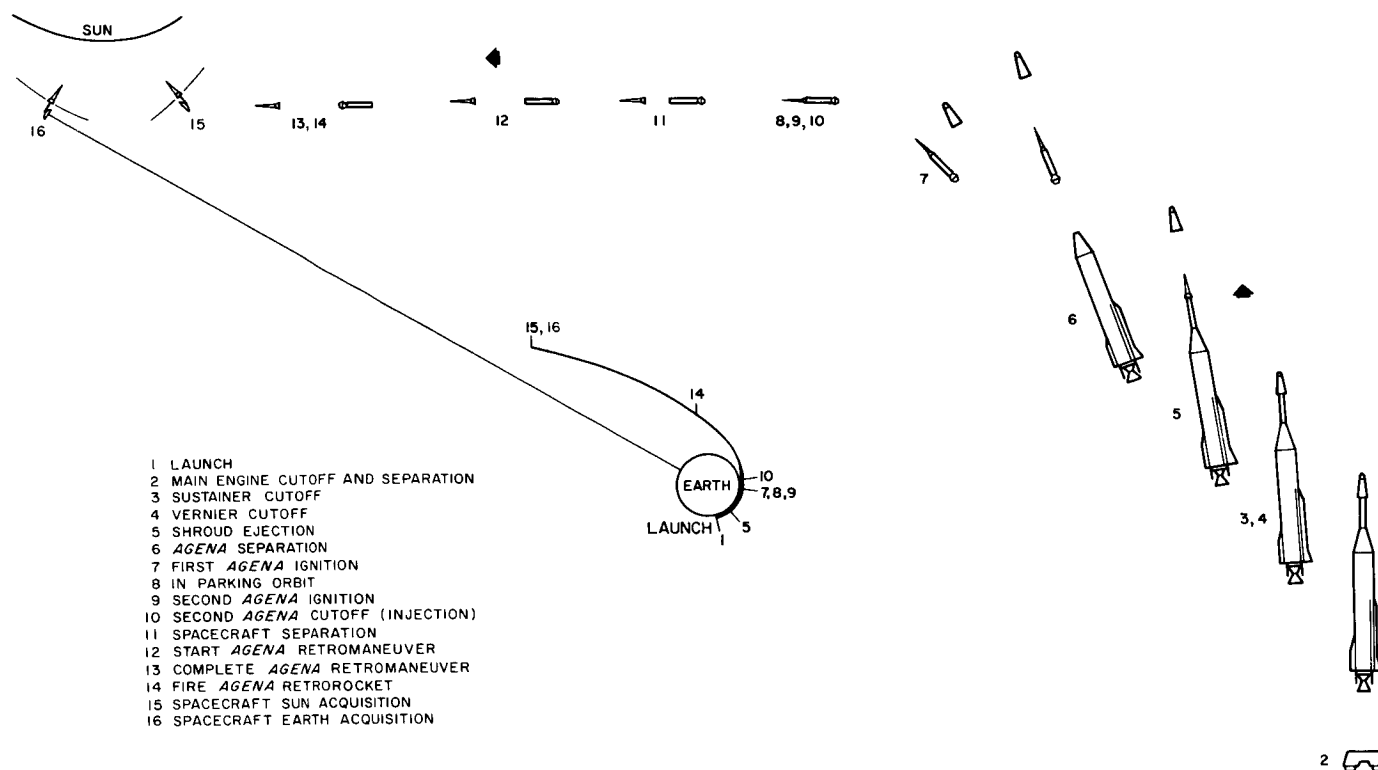


Fig. 22. Sequence of events to Earth acquisition

were sent to the spacecraft by DSIF-41 at 2119, resulting in the omni to high-gain antenna change over.

The spacecraft trajectory was such that an early mid-course correction could be chosen to cause impact in the

desired lunar region. At 0900 on July 29, the stored commands SC-1, SC-2, and SC-3 were transmitted to the spacecraft by the Goldstone Echo Station (DSIF-12), and verified as correct. The beginning midcourse maneuver command (RTC-4) was transmitted to the spacecraft at

Table 9. Nominal view periods and actual tracking of Ranger VII at DSIF stations

Date	DSIF station	Nominal rise, GMT	Nominal set, GMT	Nominal view period, hr:min:sec	Acquisition by station, GMT	Loss of signal by station, GMT	Actual view period, hr:min:sec
July 28	51	1721:17	1732:00	00:10:43	1721:38	1732:55	00:11:17
	59	1721:17	1732:00	00:10:43	1720:50	1737:53	00:17:03
	41	1736:54	0046:21 ^a	07:09:27	1735:24	0117:00 ^a	07:41:36
	51	2042:52	0828:04 ^a	11:45:12	2045:50	0854:29 ^a	11:68:39
July 29	12	0711:54	1836:01	11:24:07	0634:15	1845:35	12:01:25
	41	1438:45	0124:04 ^a	10:45:19	1413:55	0149:00 ^a	11:35:05
	51	2200:10	0848:32 ^a	10:48:22	2202:45	0912:03 ^a	11:09:18
July 30	12	0720:28	1859:03	11:38:35	0655:30	1859:49	12:04:19
	41	1459:08	0131:08 ^a	10:32:00	1436:03	0159:00 ^a	11:22:57
	51	2214:05	0853:41 ^a	10:39:36	2213:17	0914:37 ^a	11:01:20
July 31	12	0722:02	1325:50 ^b	06:03:48	0700:56	1325:50 ^b	06:24:54

^aNext day
^bLunar impact

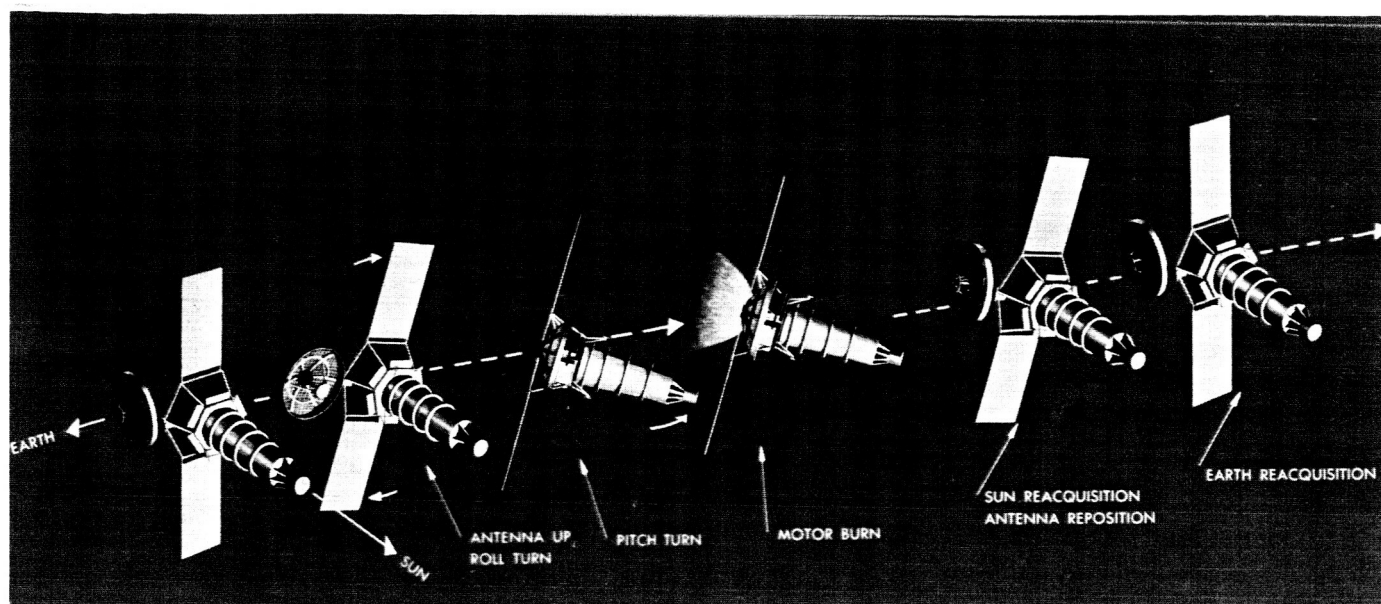


Fig. 23. Ranger VII midcourse maneuver

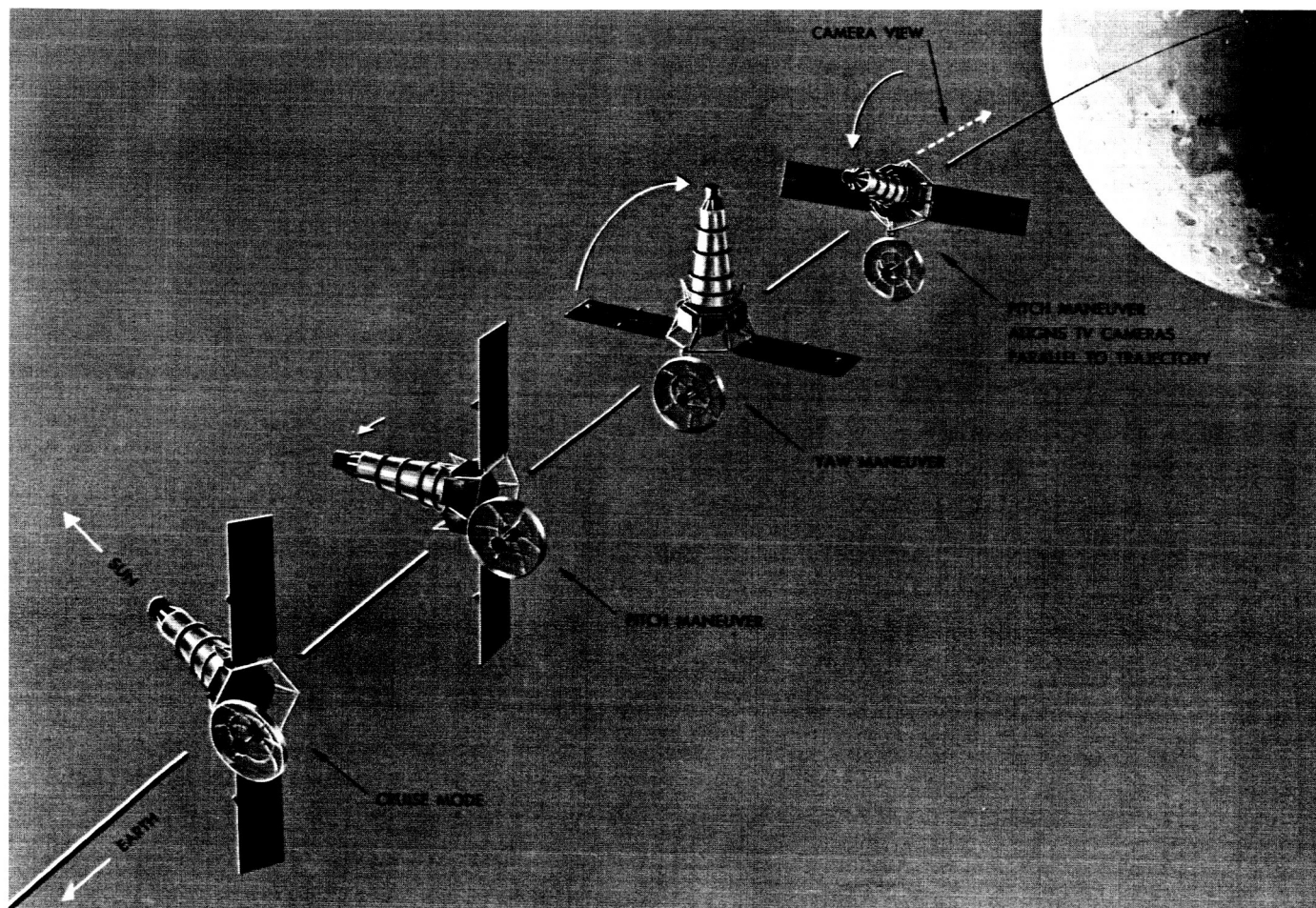


Fig. 24. Ranger VII terminal maneuver

1000 and successfully performed. At 113000 the spacecraft reacquired Earth and continued in the cruise mode.

The spacecraft remained in the cruise mode until 1130 on July 31, when the terminal commands were transmitted. Since the spacecraft was correctly oriented, a terminal maneuver was unnecessary. Terminal maneuver philosophy consisted of sending stored commands to the spacecraft that would cause a minimum gyration. The terminal maneuver was then inhibited with an RTC-8 command. The execute terminal maneuver command (RTC-6) was transmitted to the spacecraft at 122508. The spacecraft began to respond to the pitch, roll, and pitch sequence of commands, but no spacecraft movement was noted. This was the desired result of the command sequence. The purpose of the execute terminal maneuver command was to set an additional back-up timer for the video system.

At 130717 the Goldstone station received an indication that the TV cameras had gone into warm-up mode. At 130840 channel F video appeared, and from all indications, video was of excellent quality. Channel P went to full power at 131207 and 1 sec later, Goldstone reported the reception of excellent photographs of the lunar sur-

face on both video channels. Continuous video of excellent quality was received by Goldstone until impact at 132549 on July 31, 1964. During the 14 min interval prior to impact, the *Ranger VII* spacecraft transmitted to earth an unprecedented 4,340 pictures of the lunar surface.

C. DSIF Configuration

The configuration of the DSIF for the *Ranger VII* mission consisted of four permanent Deep Space Tracking stations, a Spacecraft Monitoring Station, and a Mobile Tracking Station. The permanent DSIF network was comprised of stations at Goldstone, California (Pioneer, DSIF-11, and Echo, DSIF-12); Woomera, Australia (DSIF-41); and Johannesburg, South Africa (DSIF-51). The Spacecraft Monitoring Station, DSIF-71, with its manually-operated, six-foot antenna, was located at Cape Kennedy, Florida. The Mobile Tracking Station DSIF-59, equipped with a 10-ft-diameter, parabolic-reflector antenna was located near the DSIF-51 station in South Africa. Block diagrams of the equipment at each of the DSIF stations are presented in Fig. 25-30. The capabilities and characteristics of the DSIF for *Ranger VII* are presented in Table 10.

Table 10. DSIF capabilities and characteristics for *Ranger VII*

	DSIF 71 Launch Station	DSIF 59 Mobile Tracking Station	DSIF 11 Goldstone Pioneer Station	DSIF 12 Goldstone Echo Station	DSIF 41 Woomera Station	DSIF 51 Johannesburg Station
1. Antenna size	6-ft (Az-El) (No angle data)	10-ft (Az-El)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)
2. Maximum angular rate	Manually operated	20 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes
3. Antenna gain (960 Mc) tracking feed Horn feed	— 20.5 db	23.5 db \pm 0.2 —	— 45.7 db \pm 0.8	— 45.7 db \pm 0.8	43.7 db \pm 0.9 —	43.7 db \pm 0.9 —
4. System noise temp in °K	1000 \pm 100	950 \pm 100	110 \pm 20	110 \pm 20	240 \pm 25	240 \pm 25
5. Transmitter power	—	25 w	—	200 w (50 w backup)	200 w	200 w
6. Data transmission a. Angles—doppler b. Telemetry	— Real time ^a	Near-real time None	Record TV only	Near-real ^b time Near-real time Real time ^a	Near-real time Near-real time Real time ^a	Near-real time Near-real time Real time ^a
7. Decommuted telemetry	No	No	No	Yes	Yes	Yes
8. Command capability	No	No	No	Yes	Yes	Yes
9. Air freight time to JPL	2 days	7 days	1 day	1 day	7 days	7 days

^aSent to the Telemetry Processing Station (TPS) via wide-band telephone line.
^bAngle data not the result of autotrack operation.

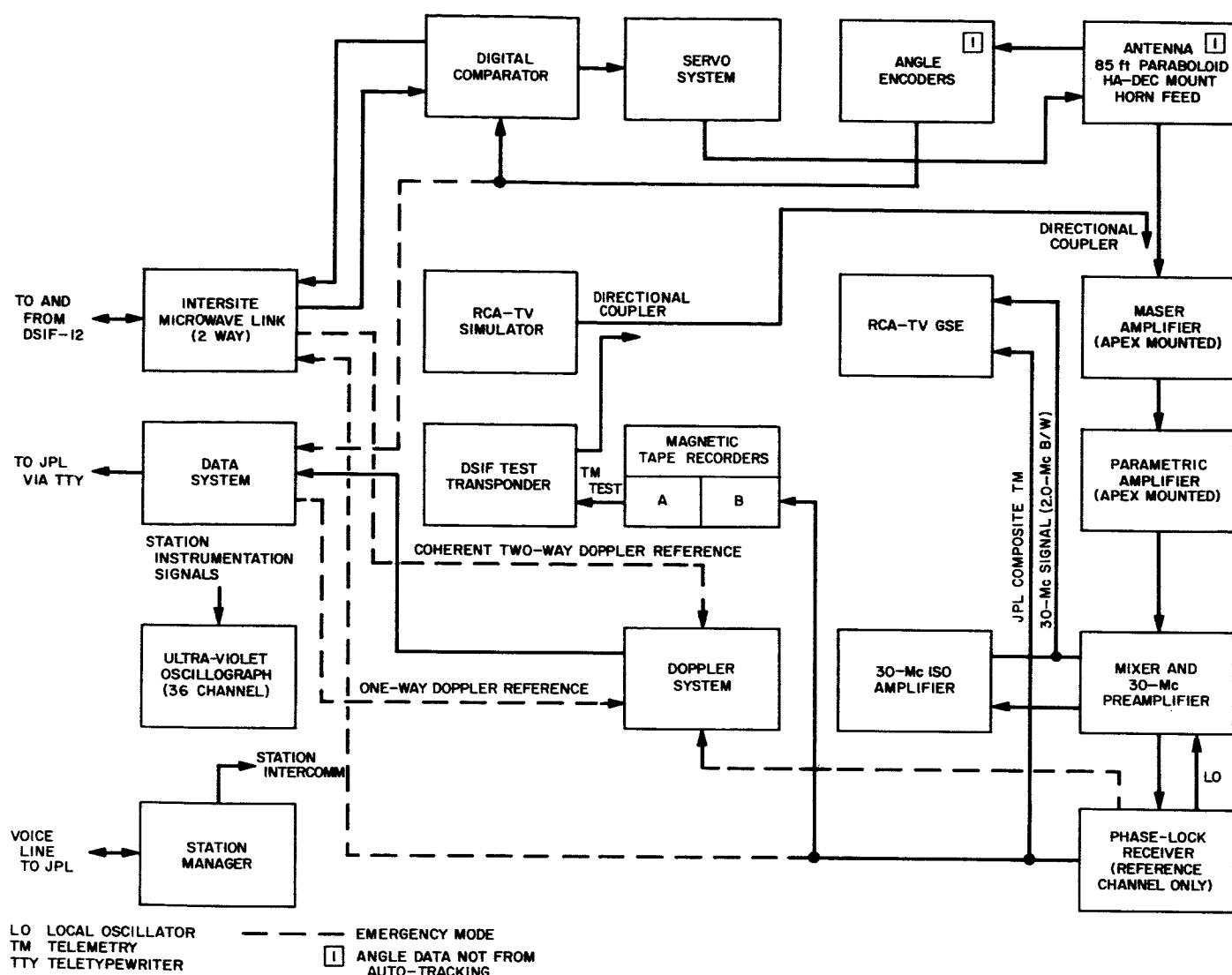


Fig. 25. Pioneer (DSIF-11) configuration for Ranger VII

During the five-month period following the *Ranger VI* mission, the DSIF prepared for the *Ranger VII* and *Mariner Mars* missions of 1964. The overseas stations, DSIF-41 and DSIF-51 were converted to an L- to S-band configuration in this period, but for practical purposes, L-band operation for *Ranger VII* was identical with that for *Ranger VI*.

Some new equipment, including mission-oriented items, was installed at DSIF stations following *Ranger VI*. New command systems were installed at DSIF-41 and DSIF-51 which increased the confidence in the stations' ability to transmit commands to the spacecraft at any time. New telemetry discriminators installed at the DSIF-11, -12, -41,

and -71 stations had approximately the same threshold as the earlier systems, but could be locked onto the spacecraft signal more rapidly and would remain in lock under more adverse conditions.

In addition to the above equipment, a special recorder was installed at each of the DSIF stations to measure, simultaneously, the time of spacecraft events in two observing stations. This information is very useful in determining time differentials between the DSIF stations. The special recorders were also capable of measuring precisely the time of impact. A master equipment list of the DSIF L-band configuration used during *Ranger VII* is presented in Section I of this Report.

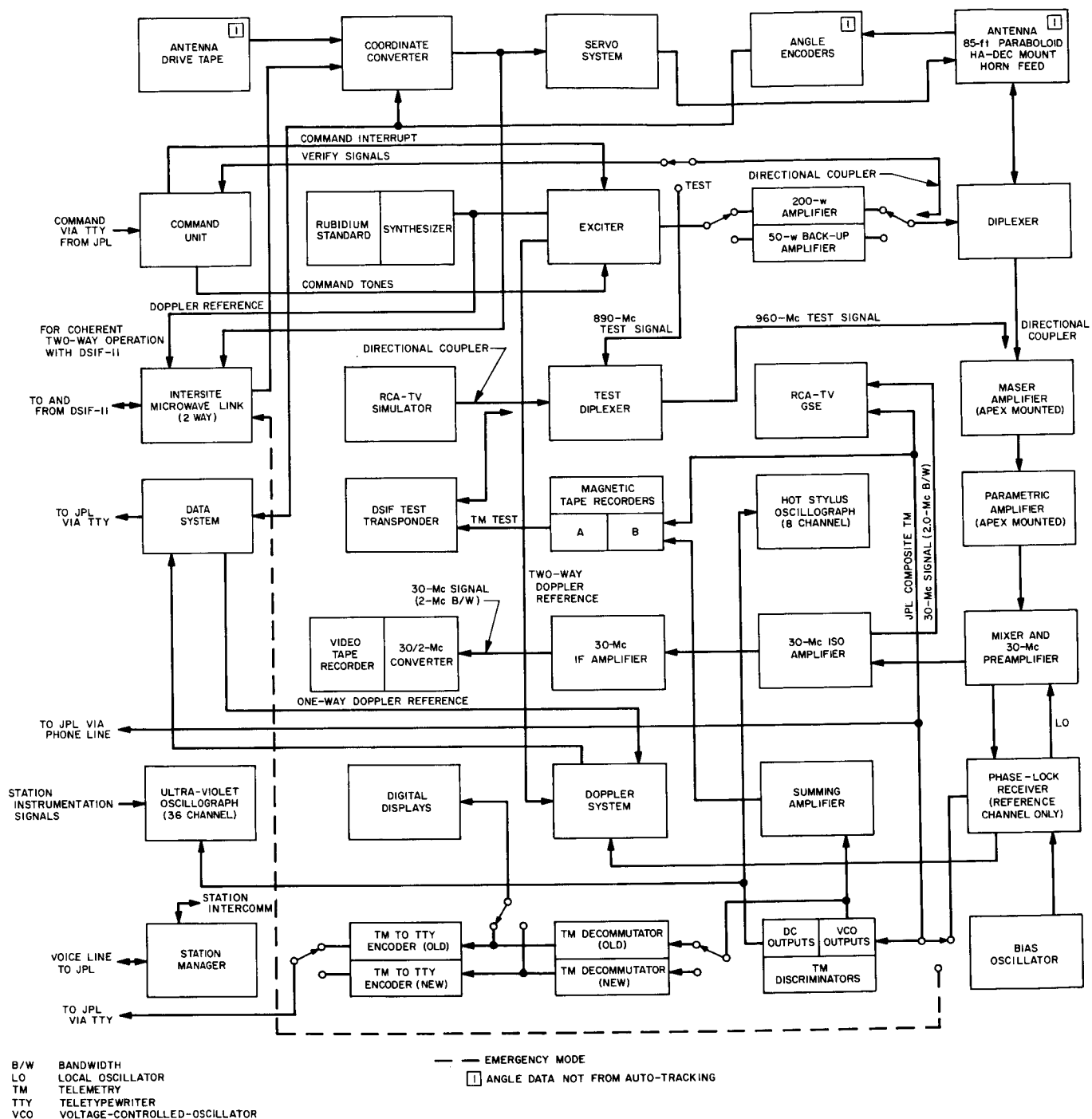


Fig. 26. Echo (DSIF-12) configuration for Ranger VII



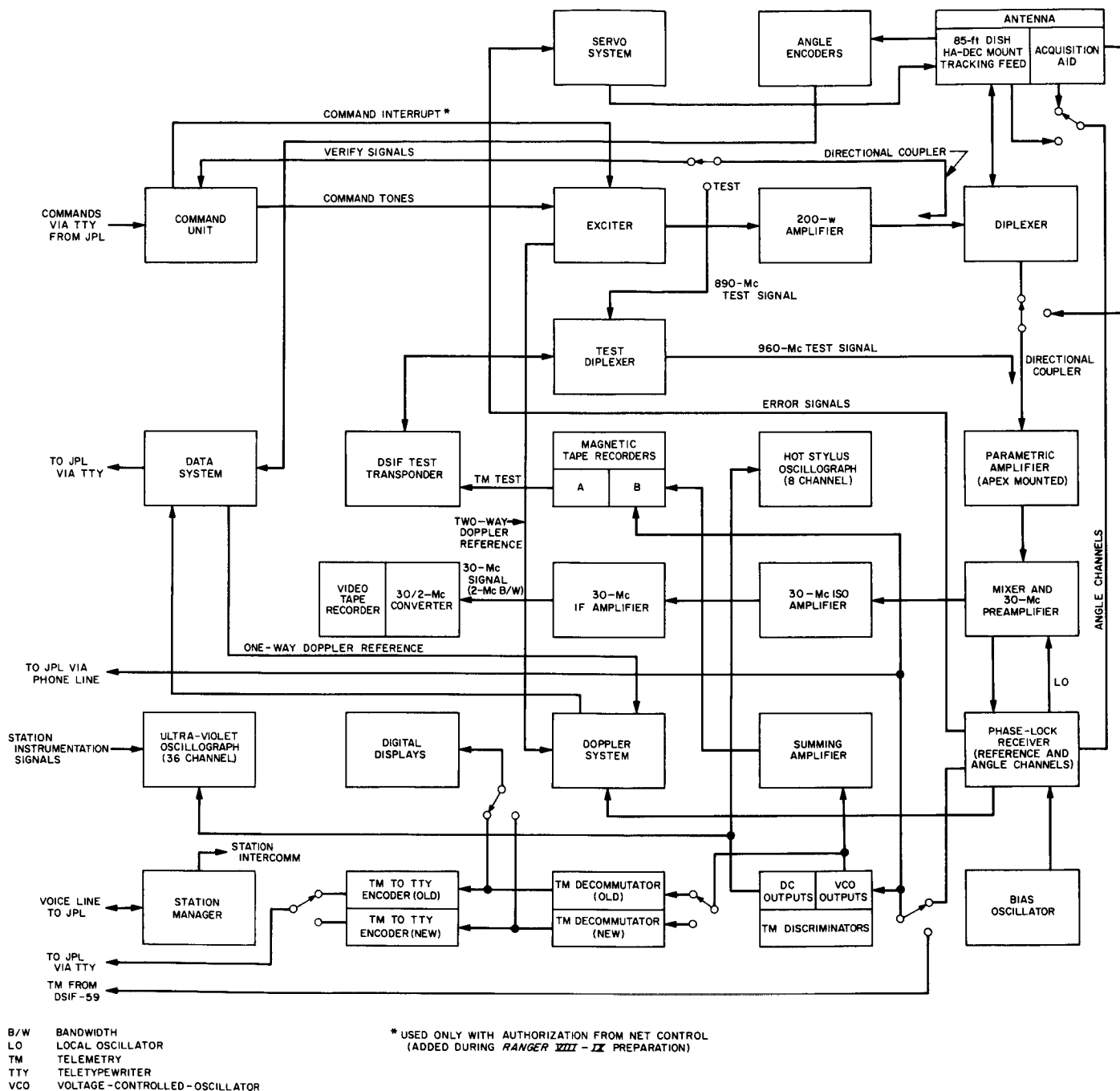


Fig. 28. Johannesburg (DSIF-51) configuration for Ranger VII

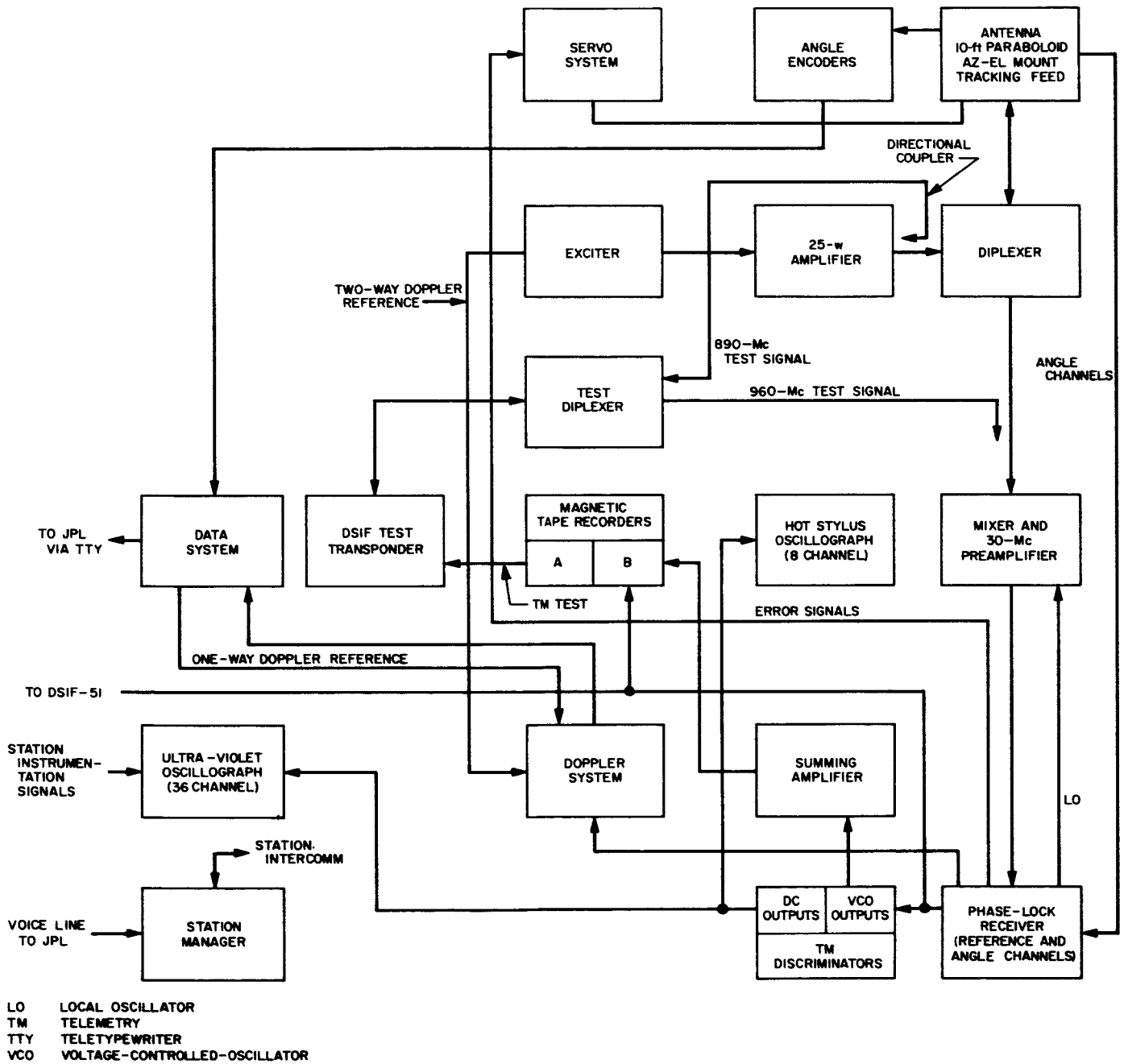


Fig. 29. Mobile tracking station, Johannesburg (DSIF-59) configuration for Ranger VII

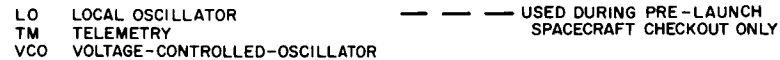


Fig. 30. Spacecraft monitoring station, Cape Kennedy (DSIF-71) configuration for Ranger VII

D. DSIF Preparation for Mission

The DSIF stations and Net Control participated in calibration and checkout test activity prior to *Ranger VII*. The test activity, which consisted primarily of comprehensive system and subsystem checks to ensure compatibility, reliability, and operator proficiency, were conducted as part of the overall operational readiness for the mission. The overseas DSIF stations, after modification associated with the *Mariner Mars* mission conducted premission tests to exercise the new equipment configuration. A series of operational readiness tests were conducted just prior to launch to exercise components of the entire Space Flight System.

The only significant difficulties experienced during the testing phase were in the area of procedures and test data simulation. Since difficult testing conditions improve the ability of an operations team to react to non-standard conditions during a mission, it was felt that the difficulties experienced were of considerable value.

A problem of great concern, involving receiver difficulties at DSIF-51, occurred several days prior to launch. The nature of the failure was discovered, however, and repairs were made prior to launch. The same problem was not experienced during the rest of the mission.

1. Net Control Activity

The *Ranger VII* mission was the first space flight activity to be controlled and operated from the new Space Flight Operations Facility (SFOF) at JPL. The new Net Control area provided greater room and space for additional equipment than in the previous SFOF. New operational procedures were devised for the control area and some of these required installation of specialized equipment. Six switchable teletype printers were installed, two of which were modified to display the *Ranger* teletype encoded telemetry. In addition to these, two keyboard-send machines, two tape perforators, and two tape readers were provided as part of the operational equipment. To facilitate the interpretation and verification of commands which were retransmitted from the stations back to Net Control, an additional tape reader was installed above the desk for the Track Chief, a newly created position. An electrowriter system was installed between the Track Chief position and the Net Man position to facilitate the delivery of information to the Net Man should he be unavailable for voice communications.

A new Operation Voice Control System (OVCS) provided talk and listen capability on important nets, inter-

communications capability to other areas, and a telephone system with hands-off speaker phone operation. In addition to the OVCS system, each Net Control console was provided with two television monitors switchable to various cameras in the area including incoming teletype lines, outgoing teletype lines, and area surveillance. A desk was provided for each of the advisors and each one had his own OVCS position for intercommunication with his particular area.

Controls for electrically operated status boards were also provided in Net Control. These boards indicated the status of the DSIF stations, and also the required communications configuration for the lines coming in from the stations. In general, the facilities provided in the new Net Control area were adequate for support of the mission and only minor modifications were required prior to launch.

2. DSIF-11, Pioneer Prelaunch Activity

Prelaunch activity at DSIF-11 included the installation and modification of station equipment, and participation in integration and operational readiness tests. Some conversion from S- to L-band configuration was also required at the station prior to support of the mission.

A new model ITT 30-Mc distribution amplifier was installed to correct a problem of low receiver threshold level of -160 dbm. The doppler counter was modified to perform a period type measurement which would allow greater accuracy in measuring the doppler frequency. The modified counter was used for special experiments conducted during the mission.

The station also converted the antenna back to the L-band configuration on July 18 and 19, 1964 following participation in S-band test program. Conversion consisted of removing the S-band line and installing and testing the L-band horn.

Participation of DSIF-11 during prelaunch tests was limited as a result of the station's commitment to the S-band test program. The station took part in DSIF/SFOF net integration tests 1A and 1B on July 2 and July 21, 1964, respectively, and operational readiness tests 1 and 2 on July 20 and July 23.

Net integration test 1A was conducted with the initial maser terminated in an ambient load. The station participated only in the impact or Phase 3 portion of the test with all systems functioning within specifications. The

receiver, however, could not be completely tested since no feed horn was installed on the antenna.

Net operational readiness test No. 1 was the first test following the installation of the L-band horn. During the countdown the closed-loop receiver threshold was -160 dbm. All attempts to obtain the normal -164 dbm level prior to participation in Phase 4 of the tests were unsuccessful. All subsystems except the receiver operated within specifications.

Net integration test 1B was not preceded by the normal countdown. The precalibration period was devoted to receiver trouble-shooting. Attempts made to correct the threshold problem were unsuccessful. Start of test participation was delayed by a request from JPL to exchange the DSIF-11 and DSIF-12 telemetry test tapes. The test started after the tape was synchronized with the proper test time. The remainder of the first 1 - 60 to impact exercise and the entire second exercise were completed successfully and without incident. Trouble-shooting of the receiver was resumed immediately following the test.

The receiver threshold problem had not been corrected by the start of operational readiness test No. 2 on July 23. All equipment, except the receiver, operated within specifications during Phases 3 and 4 of the test.

3. DSIF-12, Echo Prelaunch Activity

Preparation for the mission involved test activity and some minor changes and adjustments; but basically, the L-band equipment remained unchanged. The new Electro-Mechanical Research (EMR) discriminators were installed to replace the ones used in the *Ranger VI* mission, and proved to be more reliable. The B-19 channel for the Beckman decommutator was redesigned to improve its operation. The RWV command system received a new Nems-Clark L-band receiver, and minor modifications and adjustments were made to improve the subsystem performance. The *Ranger/Mariner* TTY encoder was modified to enable transmitting data on a high-speed data line. A series of decom/encoder tests were performed between DSIF-12 and JPL for equipment evaluation. A new acquisition panel was installed and tested for a receiver. A new 30-Mc distribution/isolation amplifier was installed and tested. Bandwidth tests with the RCA video equipment were performed and the bandwidth established as 3.6 ± 0.2 Mc, adequate for both channels. Modifications were made to improve the transmitter switchover from the 200-w mode to the 50-w back-up transmitter.

Preparation also included the installation of the trailer-mounted telemetry monitoring facility near the control building. This facility provided an on-site readout capability and allowed operators to determine the good/bad condition of the decommutated telemetry data being transmitted to JPL.

The following tests were conducted by the station in preparation for the mission:

1. DSIF/SFOF integration test 1, July 2, 1964
2. DSIF training test 1, July 6, 1964
3. DSIF/SFOF integration test 2, July 15, 1964
4. Operational readiness test, July 20, 1964
5. DSIF/SFOF integration tests 1B, July 21, 1964
6. Operational readiness test 2, July 23, 1964

a. DSIF/SFOF integration test 1. During Phase 3 of the test, the transmitter coolant line developed a small leak which was discovered and repaired during the countdown. The system operated normally for most of the tracking period. The receiver reported a 3.0 db shift, decreasing the signal level. A maser gain check failed to indicate any cause at the time. Numerous tape distortions began to appear which were too frequent for continual reporting. They occurred with random frequency for the duration of the test. The receiver reported suspected loss of crystal current in the antenna-mounted mixer, and for the duration of the test, the receiver operators were involved in checking this portion of the receiver. The trouble was caused by a defective directional coupler used as a test line input. This problem was corrected by replacing the unit after the test. All scheduled commands were transmitted at the appropriate times.

b. DSIF training test No. 1. This test was performed as scheduled. A programmed TTY outage took place during the test which required back logging of data and delayed transmission to JPL. Some trouble was experienced with simulated doppler changes causing the discriminators to go out of lock. Transponder frequency was changed to simulate doppler shift. This proved to be a very sensitive adjustment and caused the receiver to drop lock briefly several times. All scheduled commands were transmitted at times specified and event blips verifying their receipt were received. A defective module caused the RWV to begin running continuously during the test and was corrected by replacing the module. No further difficulties were experienced.

c. DSIF/SFOF integration test No. 2. The test began with station countdown and lasted about 12 hr. Equipment performance during this test was normal and all commands were transmitted at the times scheduled with verifying event blips received. No equipment failures were reported and the test ended with a normal tracking period indicated throughout.

d. Operational readiness test No. 1. During the countdown of this test, the receiver 30.455-Mc VCO and the 31-Mc VCO were replaced. The transmitter No. 2 VCO was inoperative and remained so during the test. Phase 3 of the test proceeded without incident. Telemetry reported extra time readouts appearing on a TTY encoder, which were not affecting the data. TTY communications to JPL was lost momentarily, the difficulty appearing to be at JPL. Communications were restored some 2 min later. Commands were sent and receipted for, in accordance with the scheduled times. Receiver noise was experienced when the receiver from the beginning of Test Phase 4 and telemetry had difficulty in remaining in sync. JPL reported trouble on Channel 4 which appeared to be caused by a defective discriminator. This was replaced and the transmitted data were good for approximately 9 min. The trouble was traced to a defective cable which was temporarily repaired and no further trouble was experienced. The receiver noise later began to increase in intensity and the maser group checked their equipment for a possible source. Later, noise spikes appeared from the ITT amplifier, and the subsequent maser equipment check still failed to determine the cause. The station then requested permission to turn the transmitter off for a comprehensive check. After completion of the transmitter checkout turn-on was initiated and it appeared that the equipment was not responsible. Throughout the remainder of the test, signal strength variations resulted in loss of sync and loss of modulation. As most of the system was affected and equipment had been checked, it appeared that the test tape was responsible. Scheduled operations were performed at their respective times, disregarding the effects of the bad tape; the test exercise was good.

e. DSIF/SFOF integration tests No. 1B. These tests began with station countdown and lasted approximately 6 hr. The directional coupler input to the maser caused signal changes during the countdown and was replaced. Video appeared on both Channels F and P during the test. Scheduled commands were transmitted on times indicated in the program, and this phase of the test was considered successful. This test phase, with minor variations, was successfully repeated and video appeared on Channels F and P.

f. Operational readiness test No. 2. Shortly after the beginning of this test, some irregularity appeared; however, this was cleared by resetting the receive modulation index. All scheduled events were performed, commands were sent, and verifying event blips were received. Phase 3 of the tests was successful with the system operating in the green. Some momentary loss of sync and noise bursts in both the receiver and maser trailer equipment were experienced during Phase 3, but as the tape was the one they previously used, the troubles were attributed to this source. The test was completed as scheduled and the station was ready with all systems having been tested for full operation prior to the mission.

4. DSIF-41, Woomera Prelaunch Activity

Prelaunch activities at the station consisted primarily in L- to S-band conversion; a move into a new operations room; personnel staffing and training; and *Ranger VII* test participation. Retrofit changes to the 85-ft station antenna commenced some four months prior to the mission and entailed considerable effort. Replacement activity on the antenna included changes in the quadrapod legs, declination bearings, antenna cages and equipment as well as associated L-band equipment relocation. Items installed during this period included the S-band Cassegrain cone; the hyperboloidal subreflector; the SAA and collimation tower; new optics packages; the addition of counter-balance weight and structural reinforcing; and the reinstallation of the angle encoding system.

The move into the new operations room started on June 8 and was essentially complete by June 29. While the move required strenuous effort in order to meet the time schedule, it was more than compensated for by the improved working conditions provided during the mission. Incorporation of the L- to S-band receiver, which arrived on site June 17, added to the subsystem checkout and interface problems encountered during the relocation, but these were essentially resolved before the mission.

The premission training task, associated with a large increase in staff, represented a substantial effort in view of the other preparation activities at the station. This requirement was solved by working longer hours so that training lectures could be scheduled, and by carrying out countdowns with generous amounts of pad time to allow on-the-job instruction on the various procedures. The early net exercises participated in by the DSIF-41 follow closely the pattern established for *Ranger VI*, but were of little value due to the multitude of other station activities. Of the following training exercises and tests

outlined, the two operational readiness tests did most to help the station settle into a reasonable operational routine.

1. SFOF training test 5D—May 19, 1964
2. SFOF training test 10—June 4, 1964
3. Command procedures tests—June 11, 1964
4. DSIF/SFOF net integration test 1—July 2, 1964
5. DSIF test 2—July 9, 1964
6. DSIF/SFOF net integration test 2—July 14, 1964
7. Operational readiness test 1—July 20, 1964
8. Helicopter track—July 21, 1964
9. Operational readiness test 2—July 23, 1964
10. Helicopter track—July 24, 1964

Station calibrations were also affected by the difficult time schedule prior to the mission. The approach adopted was to check that station performance was satisfactory and to take as many of the calibrations as possible. The only outstanding calibrations at the time of launch were antenna patterns, although many of the calibrations were carried out a few days behind schedule. In the case of antenna patterns, focus and null planes had been carefully checked prior to launch, and the formal patterns were taken as a post-flight calibration. The boresight vs polarization test was carried out without difficulty, but data processing problems prevented the reduced data from being available prior to launch.

5. DSIF-51, Johannesburg Prelaunch Activity

The conversion of the station to an S- to L-band configuration constituted the main activity during the period prior to the *Ranger VII* mission. Modifications to the antenna itself made it necessary to remove virtually all the RF equipment from the structure and replace it by July 10, the date set for the station to be in mission configuration.

The basic L-band receiver system configuration was retained for this mission although a substantial part of the S- to L- conversion had been carried out. It had been intended that a new S- to L- 30-Mc distribution amplifier be used, but this was found to introduce a 100 deg phase shift in the reference channel when using the bias oscillator, and the original amplifier was used for the mission. Antenna-mounted modules were installed in the lower

declination room and RF lines were rerun to the feed which was mounted in a special fixture at the apex of the new quadrapod. The receiver section encountered a number of problems prior to the mission and these are discussed elsewhere in this Report.

All antenna-mounted equipment was removed during antenna modifications and later replaced in the upper declination room. An extra T-frame was added to the equipment in the control room as part of the L- to S-conversion. The L-band configuration differed from the previous mission in that two new VCO's and the distribution amplifier were used as well as a new acquisition panel with its associated power supplies including a new switching and VCO supply for activating relays.

The Hallomare discriminators were replaced with transistorized electro-mechanical research units. Two teletype transmitter distributors were installed in place of the Kleinschmidt readers. Other installations concerned with the instrumentation system at the station included: A Midwestern 14-channel oscillograph to measure impact time accurately; a push-button signal selector panel; and a Model 28 page printer for decoding the initial Beckman decommutator tape.

No changes were made in the basic data handling system at the station for the *Ranger VII* mission, but the servo transmitter on the declination axis was removed to allow replacement of the antenna declination bearing. Before reinstallation, this unit was damaged beyond repair and another servo transmitter was used to replace it on the declination axis while the spare transmitter was installed on the hour angle axis. A number of star tracks were carried out to test this new configuration.

A new Astrodata Ground Command system was installed and checked out for the mission. The old Ransom RWV System was retained in operating condition as a standby unit.

Major modifications took place at the power station, mainly to accommodate the extra power requirements of the Data Acquisition Facility at Minitrack. Two of the 150-kw generators and the original switch and control panels were removed and replaced with three 350 kw generators and a new switch panel. This involved considerable rearrangement of other equipment including the 400 cycle generating sets. Two new 1,000 kva high voltage transformers were also installed to supply power to Minitrack.

The station conducted a series of premission evaluation tests which included eight star tracks; quadrapod deflection tests; RF boresight shift/polarization tests; aircraft tracks; and antenna pattern measurements. In addition to these, DSIF-51 participated in the following training, integration, and operational readiness tests prior to *Ranger VII*:

1. SFOF training test 5-C—May 1, 1964
2. SFOF training test 6—May 5, 1964
3. SFOF training test 7—May 7, 1964
4. SFOF training test 8—May 12, 1964
5. SFOF training test 5-D—May 18, 1964
6. SFOF training test 10—June 4, 1964
7. Command procedure test—June 12, 1964
8. SFOF training test 11—June 24, 1964
9. SFOF/DSIF integration test 1—July 2, 1964
10. DSIF training test 3—July 10, 1964
11. SFOF/DSIF integration test 2—July 14-15, 1964
12. DSIF training test 3—July 16, 1964
13. SFOF training test 5-E—July 18, 1964
14. SFOF/DSIF operational readiness test 1—July 20, 1964
15. SFOF/DSIF operational readiness test 2—July 23, 1964

As a result of a number of failures in the receiver system, the full test and evaluation requirements specified were not completed prior to the mission. The measurements affected were antenna gain and telemetry thresholds. Indication of receiver problems was first experienced during tests when the receiver dropped lock for no apparent reason. Large transients occurred on the dynamic phase error signal as viewed on an oscilloscope. This affect, however, was intermittent and did not persist long enough for logical fault-finding processes to be employed. It was later established that when this condition occurred, an abrupt change of about 1 v occurred in the output of the regulated power supply to the reference channel which included the 31-Mc VCO. This power supply was replaced.

A further indication of non-standard receiver operation was also observed in the dynamic phase error signal residual phase modulation which was greater than specified.

These faults were investigated at length with no initial success. During the DSIF Training Test No. 3 on July 10, a further fault developed. The AGC voltage became unsteady, and remained so even after the replacement of all associated modules. This was eventually traced to a faulty bias oscillator which was repaired.

A further receiver problem was a 30/29% frequency shift, loop lock, range of only 800 cycles, as against a specified 2,000 cycles. All modules had been adjusted in the workshop and were up to specification. Finally the 30-Mc phase detector was adjusted and the loop came up to specifications.

During the countdown on July 27, it was found that the receiver threshold was -158 dbm, about 4 db low. A phase detector was suspected, but replacing this with a spare did not improve the position. The countdown on July 28, showed a further alarming drop in threshold, and it was decided to install the original 31-Mc VCO which had been rechecked on the bench, and the reactance tube replaced. The threshold then returned to normal.

In spite of the faults which plagued the Receiver Section at the station throughout the tests and the countdown, this system operated without a fault or drop of lock, except for known reasons, throughout the entire tracking period of *Ranger VII*.

A fault developed in the initial Astrodata RWV System during a net integration test. This was traced to a card C-17 (F/F 12000, Flip-Flop with output on pin X). During the mission, the initial Tally Reperforator seized a bearing on the sprocket drive and was replaced with a spare which also developed a fault in the sprocket feed relay.

6. DSIF-59, Mobile Tracking Station, Johannesburg Prelaunch Activity

Following *Ranger VI*, the station was engaged in major overhaul activity on the Servo and Data Systems for a period of three months. While these more important overhauls were in progress, rehabilitation of the TV Subsystem, which is used to view the antenna from the control position, was started on a low priority basis since it is not an essential operations item at the site.

Internal subsystem premission checks commenced in mid-May and continued through June with some delays due to Data System problems. Minimizing the boresight

shift was carried out on June 22, followed by RF bore-sight vs polarization on June 24. This was repeated on July 20. Telemetry thresholds were completed July 21.

DSIF-59 participated in a total of 16 tests on the following dates prior to *Ranger VII*.

1. SFOF training tests—May 1, 5, 7, 12, and 18—June 4, 24, and July 18
2. Net integration tests—July 2 and 14
3. Operational readiness tests—July 20 and 23
4. Command procedure test (assisting DSIF-51)—June 12
5. SFOF/DSIF training test 3—July 10 and 16
6. DSIF-51/DSIF-59 telemetry capability test—July 21

7. DSIF-71, Spacecraft Monitoring Station, Cape Kennedy, Florida, Prelaunch Activity

The Spacecraft Monitoring Station (SMS) installed a project-supplied receiver and conducted extensive pre-launch tests in support of the *Ranger VII* mission. The Nems-Clark Receiver, which was received on June 8, 1964, was installed in the RF van and provided increased reliability for RWV operation over the existing receiver in the instrumentation van. Placement of the receiver in the RF van also served to increase operational speed during prelaunch testing. The series of tests conducted and participated in by DSIF-71 were as follows:

a. Station calibration on June 30. The station ran a complete calibration of all functions and all equipment was performing properly.

b. ESA checkout test on July 1, 1964. *Ranger VII* was turned on to check out the spacecraft and RF links prior to the ESA television full power test. The Midwestern Recorder in the instrumentation van failed during this test.

c. ESA television full power test on July 2, 1964. No problems were encountered with the RF van during this test. Two 14-channel Midwestern Recorders were used in the instrumentation van to replace the 36-channel Midwestern that failed on July 1.

d. Pre-countdown tests on July 6, 1964. During this test of *Ranger VII* on Pad 12, RF van operation was normal.

The instrumentation van sustained a decommutator failure which necessitated a card repair.

e. ETR combination radiation test on July 7, 1964. No station problems were noted during this radio frequency interference test of *Ranger VII* on Pad 12.

f. Special test on July 8, 1964. Station operation was normal during this test.

g. Ranger VII, J-FACT test on July 10, 1964. The station sustained a Cape Critical power failure during this first J-FACT test and switched to standby generators.

h. ESA checkout test on July 20, 1964. Station operation was normal during this test.

i. Operational readiness test 1 on July 20, 1964. The station participated in this test at the conclusion of the ESA Checkout Test by providing a tape-derived *Ranger VII* mixed signal to Hangar AM and a T-35 Report.

j. ESA full-power tests on July 22, 1964. During this final *Ranger VII* television test in the ESA area, the RWV link from Hangar AM to Station DSIF-71 failed and standby command equipment was manned by spacecraft personnel to send commands to the spacecraft.

k. Pre-countdown tests on July 23, 1964. No equipment problems were encountered during this pre-countdown test. A +7db error was evident in the 890 Mc link from calibration figures for spacecraft to gantry antenna to station DSIF-71. Tests proceeded using telemetry for a -100 dbm reference point.

l. Simulated launch on July 25, 1964. Full callibrations were completed prior to this simulated launch test. The 890 Mc link again was in error by +7 db and the spacecraft checkout circle RF equipment was utilized to verify spacecraft transponder operation. During the latter part of the test encounter both the 890 and the 960 Mc links appeared to be unstable. No RF van problems were noted.

m. Spacecraft to gantry umbilical antennas to station DSIF-71 calibrations on July 26, 1964. Upon turn-on of station equipment it was discovered that the RF van Transicold air conditioner control transformer (directly tied to the AC line) was defective. The spare air-conditioner was utilized and calibration was performed on all 890/960 links to Pad 12. The station 6-ft dish was also checked at this time for antenna pattern. The normal pattern was observed.

n. **Launch countdown on July 27, 1964.** The countdown went smoothly until the spacecraft transponder threshold was checked, and again, a +7 db error was found in the 890 link. The spacecraft circle RF equipment verified an unexplained plus value in the link to the spacecraft on the antenna. The RF air-conditioner failed during the test and a spare unit supplied by range support was utilized.

o. **Launch countdown on July 28, 1964.** A complete station calibration was completed prior to countdown. The countdown went well, and at T-20 min, the station performed doppler shift correction as the last operation for the countdown.

E. Tracking Operations

1. Launch to Injection

Ranger VII was launched at 165008 on July 28, 1964. DSIF-71 (Spacecraft Monitoring Station at Cape Kennedy) established two-way lock with the spacecraft 50 min prior to launch. This procedure was in accordance with a decision to launch with the station and spacecraft in two-way lock and maintain constant transmission until the spacecraft passed over the local horizon. At L + 31.5 sec, the ground receiver at DSIF-71 lost lock for undetermined reasons and did not reacquire until L + 148 seconds. Unfortunately, the station locked on a sideband and this mode was maintained to the horizon when signal loss occurred at L + 462 sec. During this entire period, the 890-Mc up-link from ground to spacecraft (a redundant link of telemetry supplied by the *Agena*) was fortunately maintained and the sideband lock caused no appreciable problems.

2. Injection to Midcourse Maneuver

The spacecraft was injected into a lunar transfer orbit at 172001 with *Agena* separation appearing normal and a lunar trajectory established. DSIF-59 acquired the spacecraft at 172101 and DSIF-51 at 172138. Considerable difficulty was experienced when DSIF-59 attempted two-way lock with the spacecraft which resulted in reducing the total number of satisfactory tracking data points. This was caused by the "jostling" of the spacecraft transponder by the DSIF-59 transmitter. DSIF-51 also experienced similar difficulty when instructed to attempt two-way lock with the spacecraft. DSIF-41 acquired the spacecraft in one-way lock at 173524 and established the first good and continuous two-way lock at 173848. Spacecraft events observed during this period were: solar panel extension, at 175000; initiation of the solar acquisition sequence at

175300; solar acquisition at 180500; initiation of Earth acquisition sequence at 202100 and Earth acquisition at 204400. DSIF-41 transmitted a series of commands to initiate spacecraft antenna transfer starting at 211500, with the antenna switch over (RTC-3) being initiated at 211900. This marked the first time that DSIF-41 had transmitted commands to a spacecraft. A verifying B-20 event and an increase of received signal strength were observed, indicating that the spacecraft had switched to the high-gain antenna.

3. Midcourse Maneuver to Impact

Preliminary spacecraft orbit computations indicated that a trajectory correction was required to achieve lunar impact in the pre-selected target area. Corrective midcourse maneuver commands were sent to the *Ranger VII* spacecraft by DSIF-12 at Goldstone commencing at 085000. The midcourse maneuver sequence was initiated at 100000 on July 29, 1964. The *Ranger VII* spacecraft performed as expected and post-maneuver tracking data analyses confirmed indications of a successful midcourse maneuver.

The attitude of the spacecraft as it approached the Moon, was such that a terminal maneuver was not necessary. It was decided, however, to send an RTC-6 to start the terminal maneuver, and use an RTC-8 to disconnect the attitude control subsystem from the terminal maneuver counter; this provided an additional back-up turn-off command for the television subsystem. This procedure served to inhibit the maneuver turns, but provided the back-up commands for TV warm-up and full power. RTC-6 (terminal maneuver timer start) was transmitted to the spacecraft at 122508 on July 31, 1964. Terminal maneuver functions performed as expected with no motion of the spacecraft, but with events from the CC & S indicating clock cycling. Prior to impact, DSIF-12 prepared to transmit RTC-7 back-up turn-on commands in the event that the timing systems in the spacecraft would not function. At 130715, the TV clock commanded the F-channel to the warm-up mode. At 130835, F-channel video came on with full power. At 131049, CC & S commanded television warm-up on P-channel and at 131209, P-channel came on with full power. RTC-7 was retained in the command system until impact, in the event that the television subsystem should turn off for some reason. Reception of video at both DSIF-12 (Echo) and DSIF-11 (Pioneer) was of excellent quality with all systems functioning as expected. Figure 31 is the final photograph of the impact area relayed from *Ranger VII*. Figure 32 also shows the final lunar photograph as recorded on back-up recording equipment at DSIF-12, Echo station.

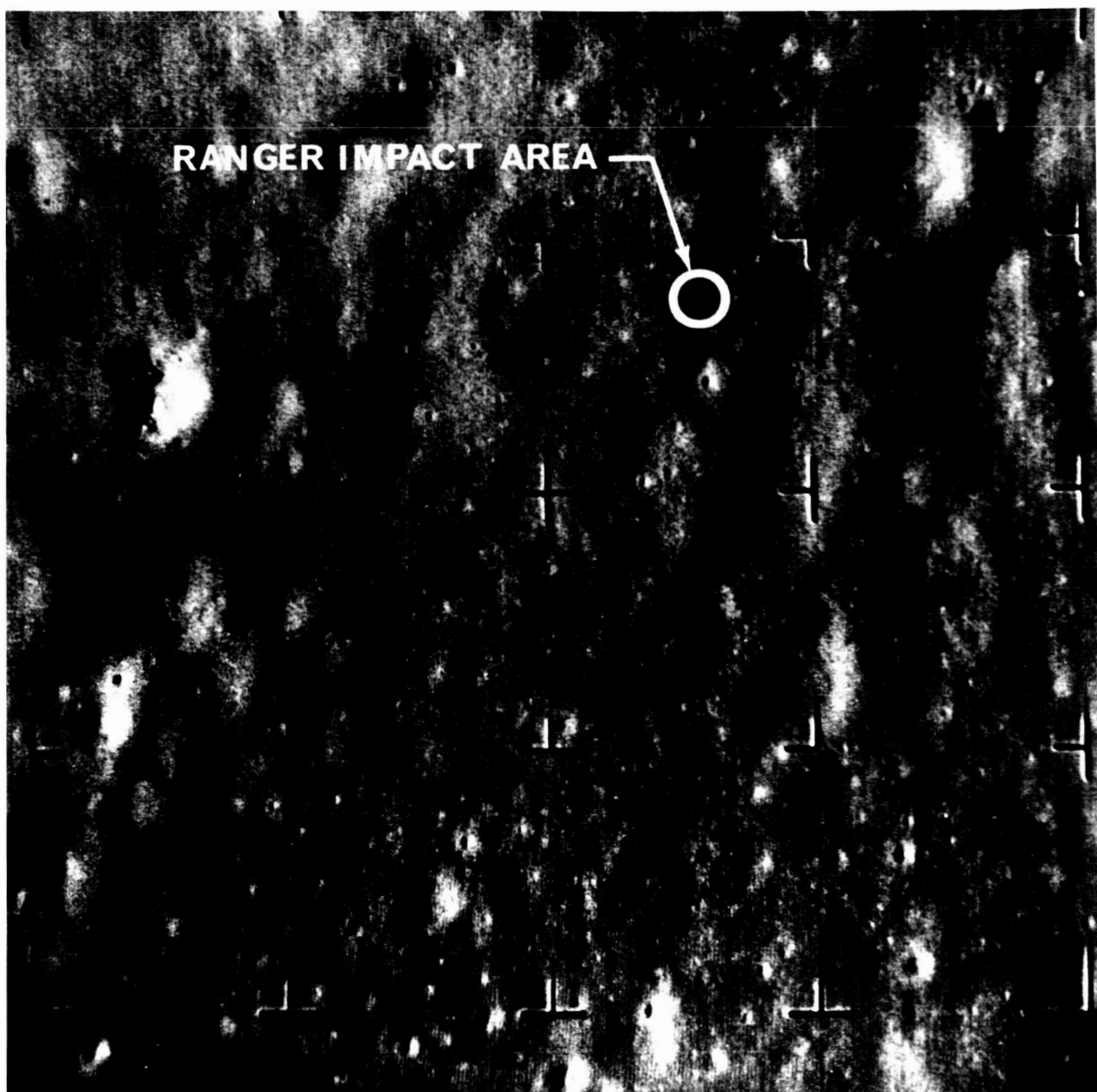


Fig. 31. Final *Ranger VII* lunar photograph

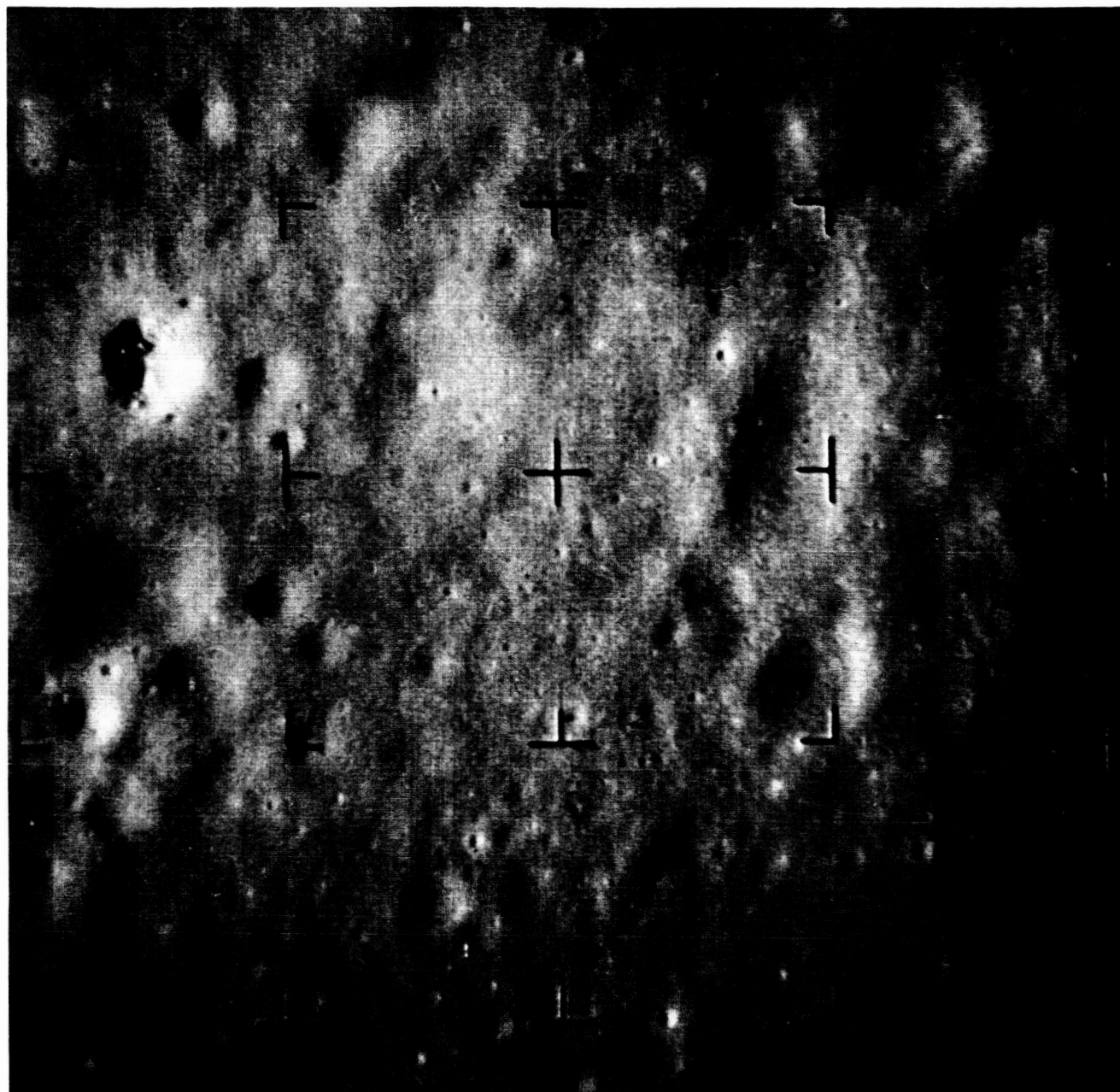


Fig. 32. Final *Ranger VII* lunar photograph recorded on back-up equipment at DSIF-12, Echo station

4. Station Tracking Operations

DSIF-tracking periods, together with nominal view periods, are presented in Table 9. Ground commands sent to the spacecraft by the DSIF station are shown in Table 11. A detailed account of tracking operations at each station is provided in the following paragraphs.

Table 11. Ground commands from DSIF to Ranger VII

Command	Initiated (date/GMT)	Verified (GMT)	DSIF station	Telemetry event blips recorded at station
RTC-0	28/211500	211538	41	
RTC-0	28/211600	211638	41	
RTC-3	28/211900	211938	41	B-20
RTC-0	29/085000	085039	12	
RTC-0	29/085200	085239	12	
SC-1	29/085400	085440	12	B-20
SC-2	29/085600	085641	12	B-20
SC-3	29/085800	085841	12	B-20
RTC-0	29/093600	093638	12	
RTC-0	29/093800	093839	12	
RTC-3	29/094000	094039	12	B-20
RTC-4	29/100000	100038	12	B-20
RTC-0	29/112100	112138	12	
RTC-0	29/112800	112339	12	
RTC-3	29/112500	112539	12	B-20
RTC-0	31/111530	111608	12	
RTC-0	31/111730	111809	12	
SC-4	31/111930	112010	12	B-20
SC-5	31/112130	112210	12	B-20
SC-6	31/112330	112410	12	B-20
RTC-0	31/115100	115138	12	
RTC-0	31/115300	115339	12	
RTC-8	31/115500	115538	12	B-20
RTC-6	31/122508	122547	12	B-20
Real time commands		Stored commands		
RTC-0 = Clear command		SC-1 = Midcourse maneuver roll duration		
RTC-3 = Antenna switchover		SC-2 = Midcourse maneuver pitch duration		
RTC-4 = Begin midcourse maneuver		SC-3 = Midcourse maneuver velocity increment		
RTC-6 = Initiate terminal maneuver		SC-4 = Terminal maneuver first pitch duration		
RTC-8 = Maneuver override		SC-5 = Terminal maneuver yaw duration		
		SC-6 = Terminal maneuver second pitch duration		

a. DSIF-71, Spacecraft Monitoring Station. At T-50 min the station went into two-way lock with the spacecraft at full power (39.5 dbm). The spacecraft receiver showed a -63 dbm signal. The received signal power at this time was -90 dbm. At T-20 min, a ground transmitter VCO was offset from 29.668120 to 29.668594 to perform doppler shift. The station receiver band-width was 150 cps and the AGC time constant was 33 sec.

The station receiver maintained lock with the spacecraft until L + 31.5 sec. At approximately the same time, the spacecraft checkout circle RF equipment went out of lock. At L + 148 sec, DSIF-71 reacquired the spacecraft

and locked onto a sideband. This lock was maintained to local horizon at L + 462 sec. The 890-Mc telemetry link was maintained without interruption throughout the station view period.

Due to the unfortunate sideband lock, the condition of the received telemetry data at the station was marginal. Postcalibration showed that the RF equipment at the station was operating properly.

b. DSIF-59, Mobile Tracking Station, July 27 countdown. The Mobile Tracking Station, Fig. 33, commenced operations at 0830, T-450, based on a 1600 launch, with two minor problems occurring during the period. A cooling fan for the RF box on the antenna was found to be inoperative and a replacement was fitted and in operation by 0900 with no loss of countdown time. The tens of seconds card in the data clock subsystem failed at 0906 and was replaced and in service by 0910 without further indications of trouble.

At 0930 a problem was reported in the bias system of Tape Recorder A. Initial symptoms indicated a power supply problem due to a relay failure. The relay was changed as soon as countdown conditions permitted but without improvement. Steps were then taken to energize the relay externally (this being a sealed unit) and this restored the RF bias and returned the system to a useful condition at 1645.

While sending pre-tracking reports, the station was notified that the Channel 6 frequencies were incorrectly poled. It was agreed to wait until the following morning when the position was investigated and it was found that the AGC voltage feed from radio to telemetry was inverted. The channel was repolarized on the morning of July 28.

No further problems occurred during the remainder of the countdown which concluded at 1451. The station stood by until 1816 when the mission was cancelled for the day.

c. Countdown and Pass 1, July 28, 1964. The station countdown began at 0830 following the repolarization of telemetry Channel 6. Tape Recorder A was still operated with an external power supply to the bias oscillator relay since it was decided not to attempt to repair the internal wiring of the system immediately prior to the mission. The countdown proceeded without difficulty and was completed at 1417.

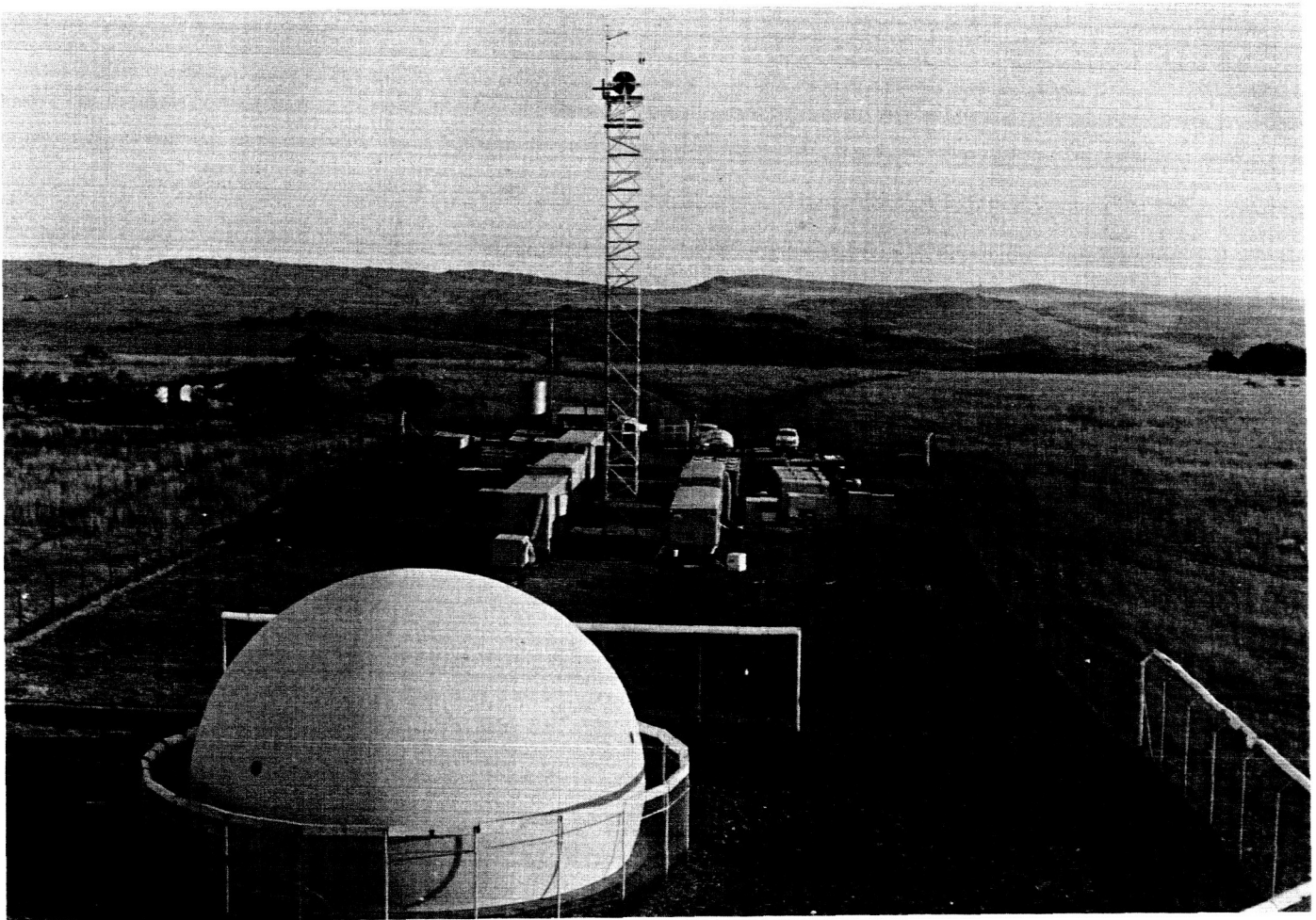


Fig. 33. DSIF-59, mobile tracking station, Johannesburg

All station systems were in the green when liftoff occurred at 165008. The recorders were switched on at 1715 and the antenna started sweeping the horizon following the 96.0 deg azimuth nominal predictions. Radio acquired two-way lock at 172050 at an elevation of -1 degree and lock was immediately verified by 10 cps modulation. Servo was in auto at 172100 and was taken out of auto at 172139 because the antenna was being thrown out by the stop relay. The servo section immediately followed up on the 96.0 deg azimuth nominal predictions as instructed by Net Control but failed to locate the main beam during the rapid (4-min) pass across the northeastern horizon.

During this period the transmitter was on and the receiver acquired lock several times as shown, but the tracking circuits did not lock in until 173236.

172312 – receiver out of lock

172427 – receiver in lock

172550 – receiver out of lock

172806 – receiver in lock

172817 – receiver out of lock

172829 – receiver in lock

173020 – receiver out of lock

173114 – transmitter off

173236 – receiver in lock

173236 – servo in auto

173420 – receiver out of lock

173420 – servo in manual

173430 – receiver in lock

173430 – servo in auto

173753 – signal lost

An investigation made immediately following this tracking period showed that the Radio Section followed instructions carefully and that loss of lock was due to the Servo Section not acquiring the main beam. The station was not successful in following the rapidly changing predictions accurately until the vehicle had slowed down toward the eastern horizon. This was a condition that the station had never experienced prior to the mission and which could not be simulated in practice. There was also some evidence of misjudgement apparent in that the station attempted switchover to auto before the spacecraft was properly above the horizon. Tracking data for 173426 to 173751 appeared good with the signal being lost at 173753.

d. DSIF-59, Pass 2, July 29-30, 1964. No serious problems were encountered by the station during the second pass which lasted from 201143 to 085236. Servo was in auto at 201410 and all telemetry channels were in lock. Tracking data were punched continuously from 201529 and 085300. Upon acquisition, telemetry was sent to DSIF-51 where it was encoded and transmitted until DSIF-51 began receiving and transmitting its own

telemetry at 204951. During the remainder of the tracking period, DSIF-59 recorded analog data on magnetic tape and paper strip recorders.

During the second pass of *Ranger VII*, DSIF-59 lost lock for a few sec on the following occasions:

1. At 210517 and 210539, due to transmitter VCO changes at DSIF-41
2. At 212015, when the changeover to high-gain antenna took place
3. At 230600, during the practice handover from DSIF-51 to DSIF-41 when the transmitter at DSIF-41 came on 4 min early
4. At 070745, during handover from DSIF-51 to DSIF-12

The receiver at DSIF-59 experienced no loss of lock during the handovers at 215100 and 001000.

e. DSIF-51, Johannesburg. Launch Pass—July 28, 1964. The countdown at DSIF-51 (Fig. 34) started at 0730 with

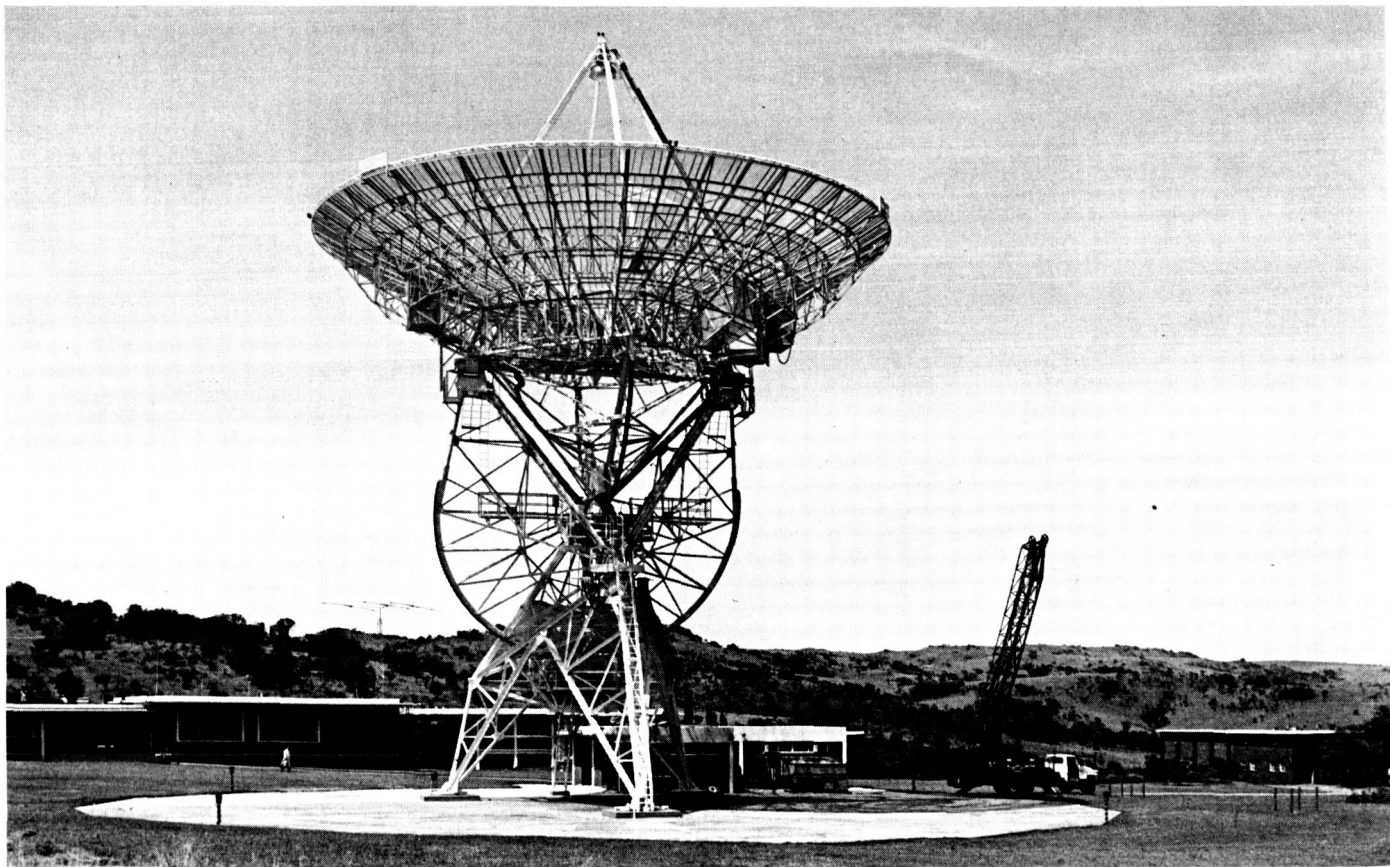


Fig. 34. DSIF-51, Johannesburg

all sections on schedule until the Receiver Section reported a poor threshold at 1140. The fault was investigated and corrected, and at 1310 the premission checks were continued. The threshold at this time was -160 dbm.

At 1420, an hour-angle front end was replaced due to loss of output from that channel. By 1620, much of the lost time had been made up and lift off was announced at 165008. The tape recorders were switched on at 1715, followed by the analog recorders and digital printer 3 min later. DSIF-59 locked on to the spacecraft signal at 172050 and telemetry tones from that station were patched to the analog circuit at 172100, while being decommutated at DSIF-51. Signals were heard at 172132 and the receiver locked on at 172138.

Servo was in auto-track at 172153 and acquired the spacecraft in the main beam 3 sec later. The signal transferred rapidly to -85 dbm. At 172220, the receiver went out of lock, and for the next $9\frac{1}{2}$ min the receiver was unable to maintain continuous lock. During this period, approximately 34 out-of-lock periods were noted. At 172807, the transmitter was switched on in an attempt to take over the spacecraft from station DSIF-59. Two-way lock was achieved at 173014, Servo reached their pre-limits at 173142 and the spacecraft was lost on the eastern horizon at 173158.

Pass 1, July 28-29, 1964. During the period between launch and first pass, snap-on tests and angle-error checks were carried out. The Telemetry Section also checked both tape recorders by transmitting test telemetry tapes.

The mobile tracking station acquired the spacecraft signal at 201230 and DSIF-51 began processing their data at 201440. A B-2-1 event blip corresponding to Earth acquisition was noted at 202105. Signals were detected at 204358 and the receiver at DSIF-51 was able to lock on at 204550 with a signal strength of -125 dbm. Servo was in auto-track at 204607, acquiring the spacecraft in the main beam 20 sec later.

The signal level had risen to -120 dbm by 204835, and at 204951 DSIF-51 telemetry data was substituted for the Mobile Tracking Station data. An event blip occurred at 21939 when DSIF-41 sent an RTC command to switch the transponder to the high-gain antenna. The received signal strength rose abruptly to -107 dbm by 212130.

At 2137, preparations began for the transfer from DSIF-41. The receiver was switched to 60 cps bandwidth at 2138, and dropped lock briefly at 212910 when the

doppler mode switch was changed to "two-way." After the decommutator had been switched to decalock oscillator sink and the transmitter VCO frequency had been adjusted, the spacecraft AGC fell to -118 dbm at 2150 as station DSIF-41 reduced their transmitter power.

The DSIF-51 transmitter was switched on at 215103 at 200 w and two-way lock was confirmed. The receiver returned to 20 cps bandwidth at 220136 and the spacecraft was tracked smoothly for the next 9 hr. During this time, a transfer was accomplished to DSIF-41 without incident at 230752. Reacquisition in the two-way mode was achieved at 001002 after a non-standard transfer had been initiated on reception of 10 cps modulation from DSIF-41 at 0005.

A high-speed punch jammed during a paper change at 0422, and was restarted at 0428. At 0700 the transmitter keyed the 10 cps modulation in preparation for transferring the spacecraft to DSIF-12. A routine transfer to the GM-32 Mode was accomplished with the receiver losing lock momentarily at 070742, and the transmitter being switched off at 070800.

The receiver returned to 20 cps bandwidth at 0714 and tracking continued without incident, other than a take-up spool fault on the CEC recorder at 0841 which was rectified 7 min later, until the antenna was stopped on the horizon at 084922. Signal strength began dropping by 085104 and the receiver dropped lock at 085429 as the spacecraft went below the horizon. Telemetry and tracking conditions were good throughout this and subsequent passes.

Pass 2, July 30, 1964. Countdown for this pass began at 1600 and proceeded smoothly until 220245 when the receiver locked onto the spacecraft signal. Servo was in auto-track at 220630. Signal strength rose rapidly to -114.8 dbm and tracking continued in the GM-32 Mode.

At 2237, the paper in the Sanborn recorder broke. The data condition code indicator showed an intermittent fault at 2248, indicating that the receiver doppler loop was out of lock. The fault was traced to the data system and rectified by replacing a gating card in the doppler cage at 2336. The receiver was switched to good doppler at that time.

A faulty relay caused the telemetry discriminators to drop lock at 0050 and the discriminators were back in lock a minute later. A faulty punch sowed up in the RWV

system at 0206. The punch was replaced by 0224 and the RWV switched on again. Spurious pulses in the transmitter digital clock caused it to gain 17 sec by 0630. The clock was stopped and corrected at 0646 just before transfer of the spacecraft was started. The transmitter reduced power at 0648 and was switched off at 071220. The receiver lost lock for 5 sec at 071240, and then locked up firmly on the spacecraft in Mode GM-32.

Time synchronization checks were carried out with the high-speed recorder at 080003 and 081600, and the pass continued smoothly until the antenna was stopped at the horizon at 090806. The signal fell as the spacecraft went below the horizon, and the receiver finally lost lock at 091203.

Pass 3, July 30-31, 1964. Countdown for this pass started at 1700 and continued smoothly until receiver lock was accomplished on the spacecraft at 221317 at a signal strength of -124 dbm. Servo went into auto-track at 2223 and the signal rose to -117 dbm by 223. Transfer from DSIF-41 was successfully accomplished at 2340 when the transmitter was switched on and the spacecraft acquired in Mode GM-22 without the receiver losing lock. All systems at this station operated satisfactorily for the next 5½ hr.

Following instruction from JPL, the transmitter was switched off at 05300 and the spacecraft was acquired in mode GM-12 after the receiver had lost lock for 14 sec. At 054000, the transmitter was again turned on and the spacecraft reacquired in two-way 14 sec later. At 0636 the transmitter digital clock was stopped to correct a 3 sec gain.

Ten cycle modulation was code pulsed at 0715 in preparation for the transfer procedure, and the spacecraft was passed to DSIF-12 at 073016 when the transmitter was turned off. The receiver dropped lock momentarily at 073034 and reacquired in Mode GM-32 with DSIF-12. The received signal strength started to fall gradually at 0907 and 2 min later the horizon was visible on the Servo Section television screen. The antenna was stopped at the horizon at 091130 and *Ranger VII* set for the last time prior to its lunar encounter with the receiver losing lock at 091130.

f. DSIF-41, Woomera. Pass 1, July 28, 1964. The countdown for the first pass was uneventful and proceeded smoothly. The receiver threshold was poor (-158 dbm), a situation that was observed the previous day and attributed to the elimination of the crystal filter and the 30-Mc distribution amplifier. After the mission it was

discovered that the paramp was responsible for the poor threshold even though the system temperature indication was normal at 205°K.

Acquisition occurred at 173521 in the off frequency configuration as the spacecraft rose over the western horizon. Transfer from the acquisition aid to the main antenna was accomplished as soon as the main antenna signals were observed, and before going to auto-track in acquisition aid. Two-way lock was achieved less than 2 min later.

The first 15 min of two-way doppler data were bad because of an over-driven counter monitoring the doppler mixer output. This situation arose as a result of changed circumstances in the L-band receiver following L-S conversion. This undesirable feature had not been present in the old configuration.

In general, station operations during this first pass proceeded smoothly with only minor equipment and procedural problems being encountered.

Pass 2, July 29, 1964. Prior to the second pass, the acquisition aid relays were by-passed and attempts were made to improve the reduced threshold. These attempts were unsuccessful. In addition, the 31-Mc VCO was serviced to eliminate the erratic behavior of the dynamic phase error channel. This also was not entirely successful. During the countdown, the Astrodata RWV gave trouble and was replaced by the Ransom RWV. It was later established that the difficulties were related closely to incorrect setting of level from the verify receiver.

Station operation during the second pass was fairly smooth; the main item of concern being the fluctuating status of the paramp, but it survived the pass, and unfortunately, returned to normal operation just as post calibrations were being taken.

Pass 3, July 30-31, 1964. The paramp was returned prior to the third pass and found to be in excellent condition. An improvement in threshold of 1 db was attained. The 31-Mc VCO was changed once more and no further difficulties with dynamic phase were experienced.

Paramp instability again plagued the station during the third pass, but fortunately this appeared to have no effect on the quality of the data. Although Net Control was informed that the station was certain that the signal level drift was due to the paramp, Net Control was sufficiently uneasy to request the station to leave the spacecraft to

check the AGC calibration. The paramp was found to be 8 dbm low in gain and could not be easily corrected; the station returned to the spacecraft without further action.

g. DSIF-12, Echo. During the *Ranger VII* mission, DSIF-12 participated in pre-launch countdowns on Monday, July 27, 1964 and Tuesday, July 28, 1964, and three tracking periods ending at 0625 on Friday, July 31, 1964. The first pre-launch countdown started at 0800 and was completed at 140611 with all station equipment operating normally. Bandwidth was checked at 131409 and verified as 3.8 Mc between 28.2 and 32.0 Mc. The launch was postponed at 181732, and DSIF-12 went into stand-by awaiting word of the next launch which was scheduled for the following day.

The second pre-launch countdown started at 0800 and was completed at 1438 with the station system in the green. The bandwidth was checked at 112847 and verified at 3.6 Mc between 28.4 and 32.0 Mc. Lift-off occurred at 165009.8. DSIF-12 was informed at 174414 that injection had occurred on schedule with DSIF-41 in two-way lock. DSIF-12 went into stand-by for acquisition at approximately 0700 on July 29.

Pass 1, July 29, 1964. First Pass Operations. The first DSIF-12 view period began with station countdown at 2300. Bandwidth checks were made at 00007 and verified at 3.6 Mc between 28.4 and 32.0 Mc. The antenna was on point at 061632 with DEC coordinates 000520, and HA 271410 deg. The receiver began searching for the spacecraft at this time. At 063415, the spacecraft was acquired in pseudo-two-way lock, with the signal level varying between -130 and -135 dbm. The receiver was in 60 cps bandwidth at 0705. Single station two-way lock occurred at 070759 with a signal level of -112 dbm. The antenna had gone into slave lock at 065213. The receiver was in 20 cps bandwidth at 070933. An equidistant DSIF-51/DSIF-12 signal level of -112 dbm and a spacecraft AGC of -1.66 v was recorded at 075123. Receiver signal level was holding steady at -111.8 dbm. The pre-midcourse maneuver began at 0850 with transmission of the following commands:

1. RTC-0 initiated - 085000
2. RTC-0 completed - 085039
3. RTC-0 initiated - 085200
4. RTC-0 completed - 085239
5. SC-1 initiated - 085400
6. SC-1 completed - 085440

7. SC-2 initiated - 085600
8. SC-2 completed - 085641
9. SC-3 initiated - 085800
10. SC-3 completed - 085841

Verifying events related to the transmitted commands were received at the times indicated below:

1. SC-1 (B-20) - 085441
2. B-2-1 - 085446
3. SC-2 (B-20) - 085642
4. SC-3 (B-20) - 085842

At 0908 the station was instructed that the transmitter VCO and command modulation would remain on until the conclusion of the midcourse maneuver. RCA reported a clock advance pulse at 092246. The midcourse maneuver began at 0936 with the following commands being transmitted:

1. RTC-0 initiated - 093600
2. RTC-0 completed - 093638
3. RTC-0 initiated - 093800
4. RTC-0 completed - 093839
5. RTC-3 initiated - 094000
6. RTC-3 completed - 094039

At 094041, a B-20 event was received. The receiver signal level had dropped to -126 dbm at 094333, when the antenna switchover had occurred. The RTC-4 midcourse maneuver command was transmitted at 100000 and completed at 100038. Tracking data went to one sample per second at this time. The following verifying events were received at the times indicated below:

1. B-20 - 100040
2. B-2-1 - 100045
3. B-2-1 - 100110
4. B-2-1 - 101010
5. B-2-1 - 101642 (Channel 8 Telemetry off at this time)
6. B-2-1 - 102709
7. B-2-2 - 102713
8. B-2-3 - 102716
9. B-2-1 - 102759

10. B-2-2 - 102803

11. B-2-3 - 102806

Channel 8 telemetry was again on at 103040. Receiver signal level began to decrease at 100348, and decreased steadily. At 101642, it was -150 dbm and fluctuating. Signal level dropped suddenly to -163 dbm at 103129, but the receiver did not lose lock. At 103229, it had increased to -127 dbm, and had steadied to -126.4 dbm at 103621. JPL reported at 103705, that the midcourse maneuver had been successfully completed. At 103930, tracking data went back to one minute sample rate. The spacecraft was on the omni-antenna at this time and the signal level was holding steady at -126 dbm. Antenna switch over was initiated at 1121 with the following commands being transmitted:

1. RTC-0 initiated - 112100
2. RTC-0 completed - 112138
3. RTC-0 initiated - 112300
4. RTC-0 completed - 112339
5. RTC-3 initiated - 112500
6. RTC-3 completed - 112539

A B-20 event occurred at 112548, and the receiver level began to change at 112600. The signal level steadied to -113 dbm, and remained relatively steady until approach of the DSIF-12 station horizon, causing a decrease and reaching -136.1 dbm at 184535 when DSIF-41 acquired the spacecraft. At 123612, the telemetry digital printer was inoperative, as a result of a broken tape, but was in operation again at 124235. The "hot line" to JPL was out between 130601 and 1335. The receiver frequency counter became erratic on the tens digit at 1504. The counter was removed at 152720 and a new one installed and tested at 153424. Servo optimized the antenna at 072404 with a $+0.099$ DEC offset. Servo optimized again at 1532 and removed the previously inserted offset as there was no appreciable change in the receiver signal level. A considerable amount of ignition-type noise appeared in the system at 165336 and remained in random bursts until the end of the station view period. Glitches appeared on Channel B-20 at 1634, and continued with varying degrees of intensity for the duration of the view period. At 183144, the transmitter was reduced in power by 20 db, and the spacecraft transfer to station DSIF-41 was initiated. The antenna reached its prelimits at 184058 with coordinants of DEC 003490 and HA 087170 deg. The receiver went out of lock at 184419, and DSIF-41 was in communication with the spacecraft.

Pass 2, July 30, 1964. Station countdown for the second view period began at 0045. Bandwidth checks were performed and verified at 0619 and the antenna was on point at 063040 with coordinants of DEC 005130 and HA 271400 deg. The receiver was in pseudo two-way lock 065530 in 20 cps bandwidth. The receiver changed to 60 cps bandwidth at 070048.

Two-way acquisition of the spacecraft occurred at 071139 with a signal level of -120 dbm. The equidistant signal level was recorded at 080600 for DSIF-51/DSIF-12 as -116.6 dbm and the AGC was -1.34 v. An attempt was made by Servo at 082935 on both DEC and HA going 0.1 deg each way with no appreciable signal improvement. At 123638, telemetry changed punches with a minimum loss of data. The decomutator was changed from the low to the high-low mode for 5 min on the hr and the half-hour for the entire view period. The DC telemetry phase detector balance was adjusted to $+100$ mv within ± 5 mv at 1632. The equidistant signal level for DSIF-41/DSIF-12 was recorded as -119.6 dbm and the HEC was -1.128 v at 1659. At 172431, the RCA group reported the TV clock advanced one step.

The receiver signal level remained relatively steady at -116 dbm until daylight, after which it began to decrease holding at -119.7 dbm. The transmitter began to reduce power at 184348. The ignition-type noise previously noted was again experienced during the morning when activity began around the station. The antenna reached its prelimits at 185552 with coordinants of DEC 006090 and HA 087154 deg. The transmitter was off at 185913 and the receiver was still in lock with a signal level of -132.9 dbm. The receiver went out of lock at 185949. The station secured operations at 190033.

Pass 3, July 31, 1964. The third view period to impact phase began with station countdown at 0112 on Friday, July 31. During the countdown several slight problems were encountered and resolved, including a minute leak in the transmitter heat exchanger pump bearing, a servo DV volt outage, and shorted diode in the unfiltered AGC power supply. Bandwidth checks were conducted and verified at 063152 and the antenna was on point at 064028. At this time the receiver began searching and the spacecraft was acquired in pseudo two-way lock at 070056 with a signal level of -151 dbm. Two-way lock was acquired at 073005. The antenna went into slave at 072127. The receiver changed from 60 cps to 20 cps at 0733 with a signal level of -119.6 dbm. The antenna was in aided track from 074400 to 074452. At 0747, the receiver reported the presence of noise. The initial Channel B-20

discriminator was changed at 080120, but noise began to appear in random bursts increasing in intensity and frequency.

At 081710, telemetry reported that the noise appeared to be coming from a Sanborn recorder. An investigation was made and the two channel recorder was discovered to be feeding noise into the other recorders at 083142. This recorder was replaced with the X-Y Plotter, and remained in this configuration for the duration of the track. Ignition noise again appeared at random intervals on the receiver, but since it was planned to block entrance routes during the final portion of the track, these were not considered significant. At 092750, Servo attempted to optimize with excursions of plus and minus 0.077 deg with no appreciable change in the signal level.

The CEC recorder was stopped at 1048 as a result of a burned out lamp, which was replaced; the recorder was again operating by 1101. The station prepared for the transmission of terminal maneuver commands at 1100 when the transmitter was removed from the synthesizer and placed on the VCO. JPL instructed the station to hold the commands at 111420, but almost immediately cancelled the hold and the command transmission began at 111530. Ground commands transmitted to the *Ranger VII* spacecraft by the DSIF are outlined in the Appendix. A terminal maneuver override was initiated by DSIF-12 at 1151. A B-20 event was received at 115540.

The terminal maneuver was initiated when the RTC-6 was transmitted at 122508 and completed at 122547. A B-20 event was received at 122554 and a B-2-1 event at 122602. Receiver signal level at 123731 was -118.7 dbm. Bandwidth checks were again made and completed at 123300. A B-2-1 event was received at 123520 and one at 125222. The antenna was in aided track between 123757 and 124037. At 125355, an RTC-8 command was unloaded from the RWV and an RTC-7 was loaded at 125427. At 1256, the paper from the high-speed punch was changed. RCA reported their system operational at 130233 and DSIF-12 was then ready for the lunar photographic encounter.

At 130717, the station reported receiving 90 point telemetry with indications of battery warm-up. Success came at 130840 when Channel F video appeared on the receiver analyzer. TV control at Goldstone reported the video was clean and good. The B-2-1 event was received at 131051. At 131117, telemetry indicated Channel P batteries were in warm-up. Channel P video appeared at 131207 with full power. DSIF-12 was receiving full power

video on both channels. At 131550, a B-2-1 event was received. At this time 131870, the receiver signal level was -118.6 dbm, 0.3 dbm less than *Ranger VI* at the corresponding time. The station video room reported that the pictures received were better than optimistically hoped for. At 132355, telemetry reported that no indications of yaw, pitch, or roll were present and that the spacecraft was heading toward impact straight-on as planned. The F solar panel had been increasing in temperature and at 132438 was reported at 103°F. Reports from the station video room and JPL indicated that the video received from the spacecraft was good until impact.

Ranger VII impacted the Moon at 132550.029, July 31, 1964. The spacecraft was in the process of transmitting the final picture at the moment of impact. The antenna coordinates at impact were, DEC 007016, HA 003448 deg.

k. DSIF-11 (*Pioneer*) mission tracking operations pre-launch countdown. On Monday, July 27, 1964, starting at 0930, a complete prelaunch countdown was conducted. The only significant event occurring during the countdown was the failure of a communication line, 2 GC 2 to DSIF-12. This problem was corrected following the cancellation of the launch. The low receiver threshold problem still existed at the station and continued efforts were made to locate the source following cancellation of the launch. On July 28, at approximately 0100, changing of the non-GSDS, 30-Mc distribution amplifier was completed, and a new HEC curve was run. The receiver threshold was then found to be -165 dbm. A second prelaunch countdown was started on July 28 at 1000 and completed without incident. The launch and injection were completed and the station secured operations.

Pass 1, July 29, 1964. Station countdown for the first tracking period began at 0030 on July 29 and was completed without incident at 0617. Doppler experiments were commenced immediately after DSIF-12 acquired the spacecraft in two-way lock at 070942. DSIF-11 acquired the spacecraft and locked onto the signal at 071712, approximately 13 min below the local horizon, using the new acquisition method of matching doppler frequency. The signal level at the time of lock-up was -163 dbm, indicating that the doppler predictions were excellent. Signal level increased rapidly and all discriminators were in lock at 072348. Local horizon for the station occurred at 0730, and the antenna was started at this time in the aided track mode because of improper signals from the coordinate converter. Problems with the antenna drive signals were experienced through all three tracking periods.

Attempts to increase signal strength by optimizing the antenna position were not successful, indicating that the pointing angle data supplied were extremely accurate. At 091940, the antenna was pointed about 10 deg off the spacecraft in order to take a gain check. During these checks, it was found that the receiver gain had changed approximately 2 dbm. At the end of the tracking period, the receiver was back on the original AGC curve and this problem did not reappear. The antenna was pointed back at the spacecraft and all telemetry channels were in lock at 093740 in order to be prepared for the midcourse maneuver. At 094045, signal level variations started and continued varying until 112815 when the high-gain antenna was realigned and the maneuver was completed. The remainder of the tracking period was routine and only one minor failure occurred when the receiver digital clock-printer missed counts and was unable to maintain accurate time. The station tracking period ended at 184656.

Pass 2, July 30, 1965. During countdown for this tracking period, which began at 0030 on July 30, the CEC oscillograph was replaced and the receiver subsystem digital clock-printer was temporarily repaired. At 071541, sampling of DSIF-12 doppler began. Acquisition and lock-up occurred at 072850 with the signal level at acquisition being -164 dbm. At 0740 local horizon time occurred and the signal level was approximately -120 dbm remaining within ± 1 dbm throughout most of the tracking period. At 102113, five samples of doppler data were reported as being missed due to a tape failure. The CEC recorder paper feed failed at 1046 and temporary repair was not completed until 1137. The antenna prelimit point was reached at 190215 and the receiver went out of lock at 192049. During the period following this pass, the CEC representative made permanent recorder repairs.

Pass 3, July 31, 1965. The station countdown for this tracking period began at 0030 and was completed at approximately 0630. The spacecraft was acquired at 073015 with a signal level of -164 dbm. The signal level increased rapidly and the telemetry Channels B-2 and 8 were reported in lock. Difficulty was experienced in obtaining Channel B-20 lock due to noisy signals. Noise also appeared as large spikes on the Panalyzer at the 30 Mc setting. The noise problems appeared to be caused by electrical storms in the area. The B-20 Channel was again in lock at 082330 and no further difficulty was encountered. No adjustments or replacement of the discriminator appeared to cause the correction. At 1030 the FR 1200 recorder was turned on. Ninety-point telemetry was

reported at 130717. Video appeared on Channel F at 130837 and on Channel P at 131210. Signals were recorded at the station until impact with all subsystems generally operating satisfactorily.

F. Tracking Performance Evaluation

Tracking of *Ranger VII* by the DSIF stations was continuous throughout the mission and in general, quality of the data obtained was extremely good. Table 12 presents a summary of DSIF acquired data and statistics used in the orbit determination computations. A comparison of statistics provided in the table gives some indication of the relative quality of tracking data acquired during each pass.

1. Angular Data

Post-flight analysis of the angular tracking data from stations DSIF-41 and -51, indicated that the correction polynomials used to describe systematic angular pointing error were not adequate. This was evidenced by the large biases and standard deviations encountered in the DSIF-41 and -51 angular data after the corrections had been applied. Corrections used for the *Ranger VII* mission were derived primarily from a series of horizon-to-horizon optical star tracks conducted at DSIF-41 and -51 during 1961-62. The correction polynomials attempt to remove optical pointing error, but past missions have indicated that they do not remove total pointing error. The situation was further complicated by recent L-to-S-band conversion work at DSIF-41 and -51 which caused the coefficients to be even less adequate in removing pointing errors as shown by recent star tracks conducted at the stations following the conversion.

Residuals² plotted for the DSIF-41 first pass showed a -0.10 deg bias in hour angle and a -0.06 bias in declination. DSIF-51 second pass angular residuals indicated a bias of about +0.03 with large bias values in hour angle and a very large RMS value. As mentioned above, the large systematic errors exhibited in hour-angle at DSIF-51 were probably due to the L- to S-band conversion work. In general, quality of the angular data acquired during the mission indicated that optical pointing error correction coefficients used in the Orbit Determination Program (ODP) to describe the antenna pointing error are not adequate. The large biases and large standard deviations observed in both hour angle and declination indicated

²The term "residual" is defined as the orbit determination program computed value minus the observed value.

**Table 12. Summary of data used in the final Ranger VII orbit determination
Pre-midcourse**

Station	Data type	Sample time	Start time	End time	Points used	Standard deviation	Root mean square	Mean ^a
59	CC3	5	28/172238	28/172303	5	0.1980	0.1980	-0.0090
51	CC3	60	28/215332	29/070632	428	0.0100	0.0101	0.0003
41	CC3	60	28/175332	28/235932	252	0.0100	0.0100	0.0003
	CC3	60	29/000032	29/000532	6	0.0059	0.0065	-0.0026
12	CC3	60	29/071132	29/081132	61	0.0079	0.0080	0.0011
	CC3	60	29/081232	29/083432	23	0.0104	0.0108	-0.0028
	CC3	60	29/084132	29/095832	74	0.0141	0.0142	0.0015
Post-midcourse								
51	CC3	60	30/015232	30/064632	256	0.0140	0.0141	-0.0017
	CC3	60	30/234432	31/071432	357	0.0156	0.0158	-0.0028
41	CC3	60	29/184632	30/002332	290	0.0170	0.0172	0.0025
	CC3	60	30/002432	30/014032	61	0.0151	0.0154	-0.0027
	CC3	60	30/190132	30/233332	224	0.0183	0.0183	0.0015
12	CC3	60	29/104132	29/112732	31	0.0116	0.0116	-0.0008
	CC3	60	29/113132	29/175032	341	0.0085	0.0086	0.0011
	CC3	60	29/175132	29/184132	42	0.0095	0.0159	-0.0127
	CC3	60	30/071832	30/082232	62	0.0104	0.0111	0.0037
	CC3	60	30/082332	30/175632	564	0.0089	0.0090	-0.0001
	CC3	60	30/175732	30/185732	61	0.0093	0.0097	-0.0024
	CC3	60	31/073432	31/081932	46	0.0096	0.0100	0.0028
	CC3	60	31/082032	31/105832	151	0.0088	0.0088	0.0001
	CC3	60	31/110232	31/122432	74	0.0334	0.0342	-0.0077
	CC3	10	31/122523	31/132543	296	0.1240	0.1240	-0.0006

^aUnits are cps.

that an improved method of antenna calibration or better correction coefficients, will be desirable for future missions.

2. Doppler Tracking Data

The quality of doppler data acquired by the DSIF stations was excellent, except for the launch pass at DSIF-51 and -59. Prior to 1754 when DSIF-41 began receiving good two-way doppler, very little good data were acquired.

DSIF-41 continued to transmit in the two-way mode until 215602 when DSIF-51 assumed the transmitting assignment continuously until 230902. Transfer was then effected to DSIF-41 which retained it until the end of its pass at 001402. DSIF-51 then resumed transmission until 070902 when DSIF-12 began transmitting, obtaining approximately 3 hr of good two-way doppler prior to the midcourse maneuver.

a. Midcourse maneuver phase. The midcourse motor burn was initiated at approximately 102709, and was cut

off at about 102758. A total doppler shift was on the order of -183 cycles. During this phase, DSIF-12 took 1-sec doppler samples.

b. Post-midcourse phase. Two-way doppler from DSIF stations -12, -41, and -51 only was used for post-midcourse orbit computations. The residuals from post-midcourse passes over the stations showed the overall quality of the data to be excellent. DSIF-12 stopped using the Atomic Frequency Standard at 110002, July 31, and began using the Voltage Controlled Oscillator (VCO). A large increase in the magnitude of the residuals was noted after this time period which reflected the relative stability and reduction of noise using the atomic standard as compared with the VCO. At 122518, DSIF-12 changed from 1-min doppler samples to 10-sec doppler samples and a very large increase in the magnitude of residuals was noted.

3. Station Performance Analysis

The following paragraphs present a station-by-station analysis of the DSIF tracking performance during the mission. The analysis is based on all available data, such

as real time tracking data, in-flight station reports, station logs, and calibration records. All times listed refer to Greenwich Mean Time (GMT).

a. DSIF-59 Mobile Tracking Station, Johannesburg. Launch pass. Acquisition occurred at 172050 on July 28. The antenna servo system was put in the autotrack mode at 172100, but was taken out of the autotrack at 172139, because the antenna was being thrown out by the stop relay. The station then attempted to follow nominal predictions, but was unable to locate the main beam until 173236 from which time they tracked the spacecraft until the end of the pass at 173753. Graphs of the actual antenna pointing angles versus the predicted antenna pointing angles and the actual transmitter VCO frequency versus the predicted transmitter VCO frequency showed that the station was not able to effectively follow the predictions from 172139 until 173236. This problem on the part of the station operators was at least partially due to the high angular rates encountered during this portion of the mission. Only 5 points of 5-sec, two-way doppler samples were useable during this pass in the ODP.

b. DSIF-51 Johannesburg. Launch pass. The station acquired the signal at 172138 on July 28. The antenna servo system was put in autotrack at 172153 and the spacecraft was acquired in the main beam 3 sec later. At 172220, however, the receiver went out of lock and continuous lock was not achieved during the remainder of the pass which terminated with loss of signal at 173255. The transmitter was switched on at 172807 in an attempt to take the spacecraft from DSIF-59. At this time DSIF-51 as well as DSIF-59, indicated certain data as being good with their Data Condition Code, when in fact they were unuseable. This was illustrated by the fact that during the period 172841 to 172906 both DSIF-51 and -59 reported good two-way doppler data, a clearly impossible situation. None of the two-way doppler samples acquired during this pass were useable in the ODP.

Pass 1. The signal was acquired at 204550 on July 28. Two-way lock was confirmed at 215103. The transmitting assignment was transferred to DSIF-41 at 230752, with DSIF-51 regaining the transmitting assignment at 000102, July 29. Very good two-way doppler was recorded during the entire span of this pass. Angle data recorded during this pass were not of very high quality. Declination angle data indicated a bias of $+0.03$ deg while hour angle data indicated a rather high standard deviation of $+0.03$ degrees.

Pass 2. The signal was acquired at 220245 on July 29. The transmitter was turned on at 014536 on July 30 and

very good two-way doppler was recorded until the transmitter was turned off at 071220. Declination angle data indicated a bias of $+0.03$ deg while hour angle data showed a standard deviation of ± 0.03 deg. The end of the pass occurred with loss of signal at 091203.

Pass 3. The signal was acquired at 221317 on July 30. The transmitter was turned on at 234000. The two-way doppler recorded during this pass was reasonably good, but there was evidence of a slightly higher standard deviation than noted on previous passes. During this pass, as on previous passes, the declination angle data showed a bias of $+0.03$ deg, and hour angle data indicated a standard deviation of ± 0.03 deg. The transmitter was turned off at 073016 on July 31. The end of the pass occurred with loss of signal at 091437.

c. DSIF-41, Woomera, Australia. Pass 1. The signal was acquired at 173524 on July 28. The transmitter was turned on at 173750 and two-way lock was confirmed at 173848. Two-way doppler data of good quality, however, were not taken until 175402. This loss of 16 min of two-way doppler data was quite significant, since data taken early in the mission are of much greater importance in the ODP than data taken later. The loss resulted from an overloaded counter monitoring the doppler mixer output. The situation arose as a direct result of a changed configuration in the L-band receiver following the L- to S-band conversion and is not expected to occur again. At 215105, the transmitter was turned off to allow DSIF-51 to transmit. DSIF-41 regained the transmitting assignment at 230600 and kept it until 001050 on July 29.

The two-way doppler data recorded during this pass were very good. One occasional problem was encountered, however, when the doppler counter apparently dropped either 100 or 200 cycles when it printed out an even 100 value. An instance of this problem occurred at 212102, when a raw value of the doppler output of 1680104800 was recorded; the value, according to the determined orbit, should have been 1680104900. During this pass hour angle data showed a bias of -0.11 deg while declination angle showed a bias of -0.07 deg. Loss of signal occurred at 011700 on July 29.

Pass 2. The signal was acquired at 141355 on July 29. The transmitter was turned on at 184220 and stayed on until 014522 on July 30. Two-way doppler data recorded during this pass were good with only a few data points lost. The hour-angle data showed a bias of -0.07 deg while declination angle showed a bias of -0.03 deg. The pass ended with loss of signal at 014900.

Pass 3. The signal was acquired at 143603 on July 30. The transmitter was turned on at 185857 and was turned off at 234000. Good two-way doppler data were acquired during this entire period. During this pass the signal level was unusually low due to a marginal parametric amplifier and the receiver system; however, this does not appear to have degraded the two-way doppler data in any way. The hour angle data, during the pass, indicated a bias of -0.06 deg while declination angle data indicated a bias of -0.04 deg. The pass was ended with loss of signal at 015900 on July 31.

d. DSIF-12, Echo station, Goldstone, California. Pass 1. The signal was acquired at 064410 on July 29. The transmitter was turned on at 070730 and good two-way doppler data were taken during the entire pass. Beginning at 083602 to 113002 the station used the VCO while during the rest of the pass the station used the Atomic Frequency Standard. A comparison of the residuals during these two time periods exhibited the relative stability and the ensuing reduction of noise with the Atomic Frequency Standard. The standard deviation of the two-way doppler was approximately $+0.03$ cps during the time when the VCO was in use, while it was approximately ± 0.01 cps during the period when the Atomic Frequency Standard was in use.

The midcourse maneuver was executed during this pass. Midcourse motor burn was initiated at approximately 102709 and was cut off at about 102758. The total doppler shift was only on the order of -183 cps. During this phase DSIF-12 took one second doppler samples. The transmitter was turned off at 184241, the pass being terminated with loss of lock at 184535 on July 29.

Pass 2. The signal was acquired at 065530 on July 30. Transmitter turn on was accomplished at 070314. The atomic frequency standard was used during the entire pass and uniformly good two-way doppler data were taken. The doppler data showed a standard deviation of approximately 0.01 cps and a bias of $+0.0001$ cps. The transmitter was turned off at 185913, the pass ending with loss of signal at 185913 on July 30.

Pass 3. The signal was acquired at 070056 on July 31. Transmitter turn-on was affected at 073000 on July 31. The station used the Atomic Frequency Standard until 110002 at which time it began using the VCO. A large increase in residuals appeared at this time. Prior to this, very good two-way doppler was taken with a standard deviation of approximately 0.01 cps. At 122518, doppler sample time was changed from 1 min to 10 sec and a very

large increase in residuals was noted at that time. As was expected, the smaller sample time greatly increased the noise, the data during this time showing a standard deviation of 0.17 cps. The pass was concluded at 132550029 on July 31 by the impact of *Ranger VII* on the moon.

e. Performance summary. DSIF-59. The station acquired only 5 good two-way doppler samples during the launch pass. This unsatisfactory performance should be improved during future missions, since data from DSIF-59 are only important during the launch pass.

DSIF-51. The station was unable to acquire any good two-way doppler samples and experienced receiver lock problems during the launch pass. The subsequent three passes produced very good two-way doppler and the station encountered no further problems.

DSIF-41. The station lost the first 16 min of two-way doppler data due to an overloaded counter. This loss of data is quite important since the data taken during the early part of the mission are the most important in the ODP and are also the most important data in refining the values of certain physical constants. Other than these, however, DSIF-41 acquired very good two-way doppler data during the rest of the mission and only minor problems were encountered.

DSIF-12. The station acquired very good two-way doppler during the entire mission. Station operation was excellent and no problems were encountered.

General DSIF performance. Overall quality of the tracking data acquired by the DSIF was excellent. Problems encountered were only minor in comparison to those of past missions.

G. Participation of Non-DSIF Agencies

1. Space Flight Operations Facility (SFOF)

The *Ranger VII* mission was the first space flight activity to be completely controlled and operated from this new facility located at JPL, Pasadena, California. The SFOF utilizes operation control consoles, status and operations displays, computers, data processing equipment in the analysis of spacecraft performance and space science experiments, and communication facilities to control space flight operations. Figure 35 shows a portion of the control room in the SFOF.

a. Facility. The SFOF included a display system, an observer's gallery, television output of certain cameras

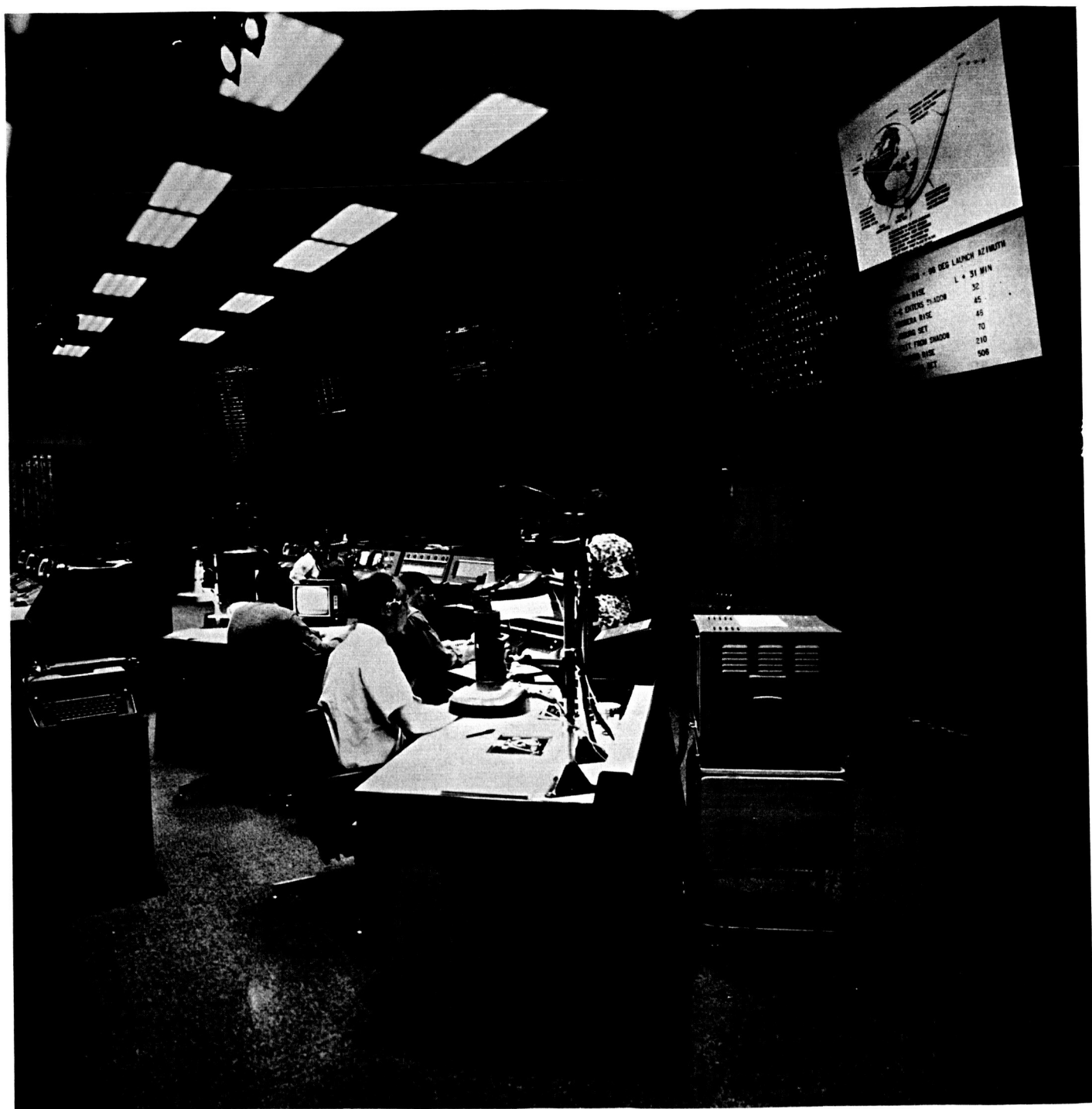


Fig. 35. SFOF operations control room during *Ranger VII*

with an audio status line for an internal-external laboratory information system, access control and facility security, stand-by maintenance personnel support, stand-by room for operations personnel, bunk room, technical area assistance support for the Spacecraft Data Analysis Team (SDAT), and the Flight Path Analysis and Command (FPAC) group, as well as the necessary capability for the correction of any facility failures, or problems.

During the mission, an internal power failure occurred in the facility at 0025 on July 31. This failure, which affected only the data processing system, was corrected by 0049. The problem was caused by a power switch which had arced to ground. A temporary repair was made during the mission and later steps were taken to prevent a reoccurrence of similar failures. Several minor display equipment failures also occurred and were fixed in near-real time during the mission.

A secure area was also provided in the SFOF, for two weeks following the conclusion of the flight, for the analysis of the lunar television pictures taken by the Space Science Analysis and Command (SSAC) group and experimenters.

b. Data processing complex. This complex consisted of two IBM 7094 computers, three IBM 1401 computers, and SC-4020 plotter, and a PDP-1 computer, the Telemetry Processing Station, and the personnel required to operate and maintain this equipment.

For three days prior to the *Ranger VII* launch, the complex executed a launch-checkout sequence of events which included testing and operations of both software and hardware. At the completion of this checkout phase, the complex had achieved a state of mission readiness.

In general, all computer programs performed well during the mission. The orbit determination and trajectory computation effort was very satisfactory with all scheduled tasks being completed in an orderly manner. Computation of the midcourse and terminal maneuver commands during the mission proved to be excellent. Real-time display of raw and converted engineering telemetry data, including television subsystem data, was supplied to the Spacecraft Performance Analysis Area by the PDP-1 computer and the Telemetry Processing Station. Bulk processing in the form of printed listings and plots of engineering telemetry data on the IBM 7094 computers was satisfactory, although more computer time was consumed than had been anticipated.

The computers and associated equipment had a good record of reliability during the course of the mission. The few equipment problems which occurred were minor, and caused little or no delay to the operations as a result of quick repair and back-up hardware capabilities, which were immediately available.

Post-flight processing of tracking and telemetry data began immediately following the completion of the mission.

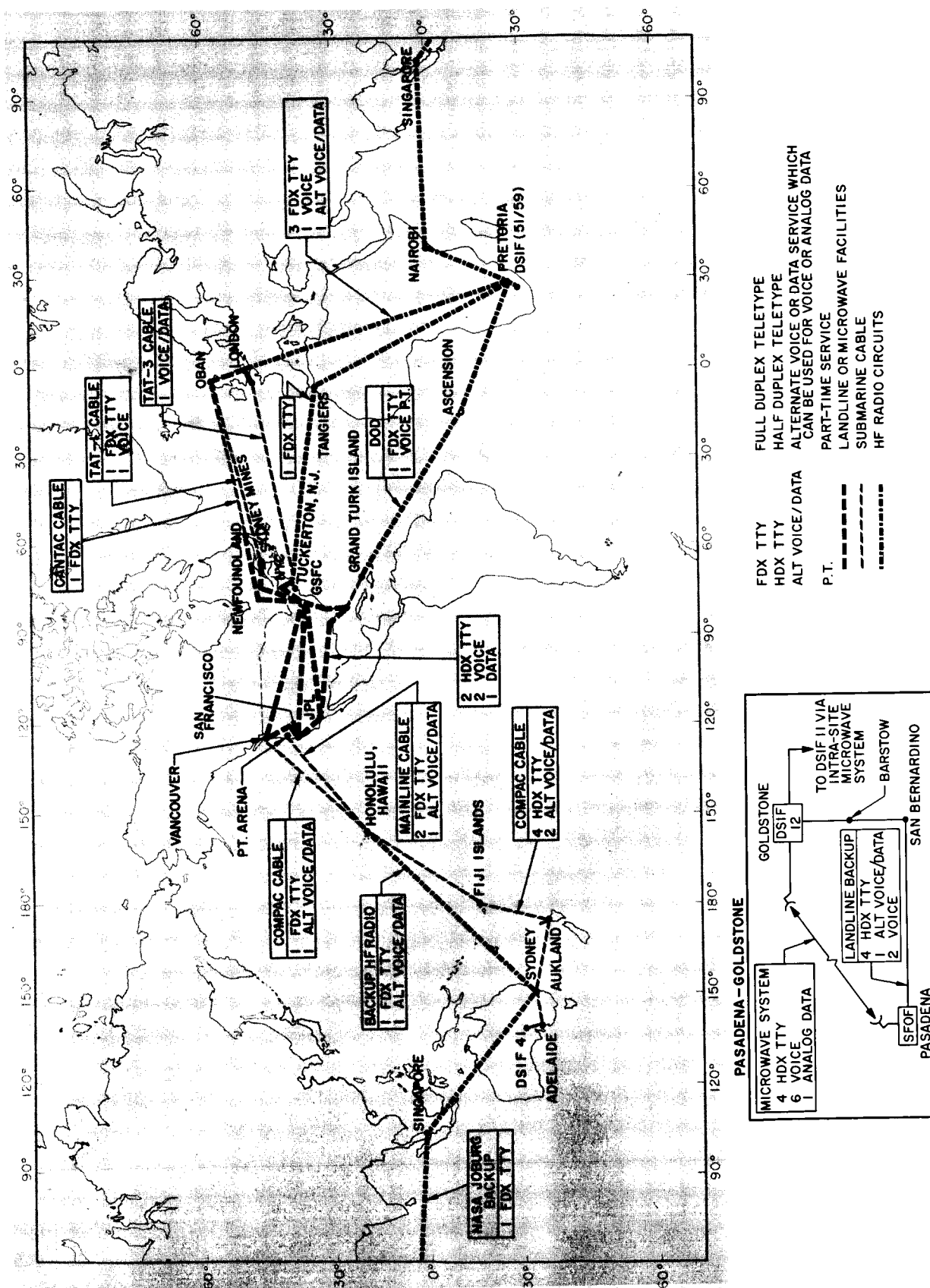
c. Communications center. Performance of the Communications Center during the flight was quite effective. The communications failures experienced within the SFOF were due to terminating apparatus only, and were of a type and quantity well within normal expectations. Mechanical failures of teletype equipment, tube and semiconductor failures, plus minor technical adjustment problems constituted all of these failures. In one instance, the teletype switching system apparently locked up for approximately 3 min. This problem was experienced during system tests and later became the subject of an engineering evaluation. The momentary lock-up caused a short loss of teletype data and was cleared by emergency operational procedures.

2. Ground Communications System (GCS)

The DSN Ground Communications System for the *Ranger VII* mission consisted of: voice, normal and high data rate teletype circuits provided by the NASA World-Wide Communications Network between each overseas DSIF station and the SFOF; and teletype and voice circuits between the SFOF, Goldstone stations, and Cape Kennedy, and a microwave link between the SFOF and Goldstone. The Ground Communications Net configuration for *Ranger VII* is shown in Fig. 36.

a. Woomera communication circuits. Teletype, analog data, and voice communications to DSIF-14 were generally excellent and much improved over *Ranger VI*. This resulted from using the new submarine cable in place of the high-frequency radio circuits. The high-frequency radio from Hawaii to Sydney (used as a back-up during *Ranger VII*) was not operationally acceptable during the flight, probably due to lack of adequate time for exercising this configuration after switching the main communications to the cable.

b. Johannesburg communication circuits. The circuits to Johannesburg again provided the most difficult communications problem during the mission. In addition to the Sydney-Pretoria "back-door" circuit installed prior to



Ranger VI, another radio teletype circuit was implemented just prior to *Ranger VII*, in an attempt to correct deficiencies in teletype and voice communication. The new circuit was made available through the cooperation of AFETR.

c. Goldstone communication circuits. During the time interval between the *Ranger VI* and *VII* missions, Goldstone communications services were transferred to the new microwave system between JPL and Goldstone. This system worked very well and permitted the transmission of the video data for real-time display during the mission.

3. Air Force Eastern Test Range, AFETR

The AFETR was assigned the responsibility of providing JPL with orbital elements of the parking and transfer orbits; acquisition information for the DSIF stations; and the raw data that would be used by JPL to provide a backup to the computations of the transfer orbit. Figure 15 shows the AFETR tracking facilities supporting the *Ranger* flights.

a. Vehicle tracking. The Mark II Azusa system at AFETR tracked the transponder in the *Atlas* Booster from $T + 5$ sec to $T + 410$ sec. Reduced data indicated a drop out at booster staging.

The coverage provided by the AFETR C-Band radar systems is shown in Table 13.

Table 13. AFETR C-band tracking coverage

Station	Type	Location	Coverage interval, range time, sec	Useful data interval, range time, sec
0	18	Cape Kennedy	24-484	23-473
1	16	Cape Kennedy	9-336	11-335
19	18	Cape Kennedy	8-310	—
3	16	Grand Bahama	67-495	70-495
5	16	San Salvador	124-565	125-565
7	18	Puerto Rico	225-595	—
91	18	Antigua	385-730	393-417; 418-692
12	16	Ascension	1243-1456	1244-1455
13	16	Pretoria	1860-2870	1845-2139; 2199-2297; 2428-2461; 2518-2528; 2640-2658; 2663-2772
		Bermuda	367-646	514-646
		Carnarvon	2461-3988	2704-3988

b. Range telemetry coverage. *Atlas*. Booster links at 229.9 and 232.4 Mc were covered as shown below (times indicated in seconds from launch):

Cape Kennedy	
Tell 2	— 420 to + 476
Tell 3	— 420 to + 491
Grand Bahama Island	+ 38 to + 500
San Salvador Island	
229.9	+ 119 to + 287
232.4	+ 330 to + 505

All *Atlas* events were confirmed by Cape Tell 2.

Agna. The telemetry link at 244.3 Mc was covered as follows (times indicated are in sec from launch):

Cape	— 420 to + 491
Grand Bahama Island	+ 38 to + 500
San Salvador Island	+ 119 to + 550
Antigua Island	+ 330 to + 738
Coastal Crusader ³	+ 535 to + 940
Ascension Island	+ 1208 to + 1470
Ascension Island	+ 1539 to + 1551
Rose Knot ³	+ 1450 to + 1875
Sword Knot ³	+ 1604 to + 1885
Pretoria, S.A.	+ 1824 to + 3040

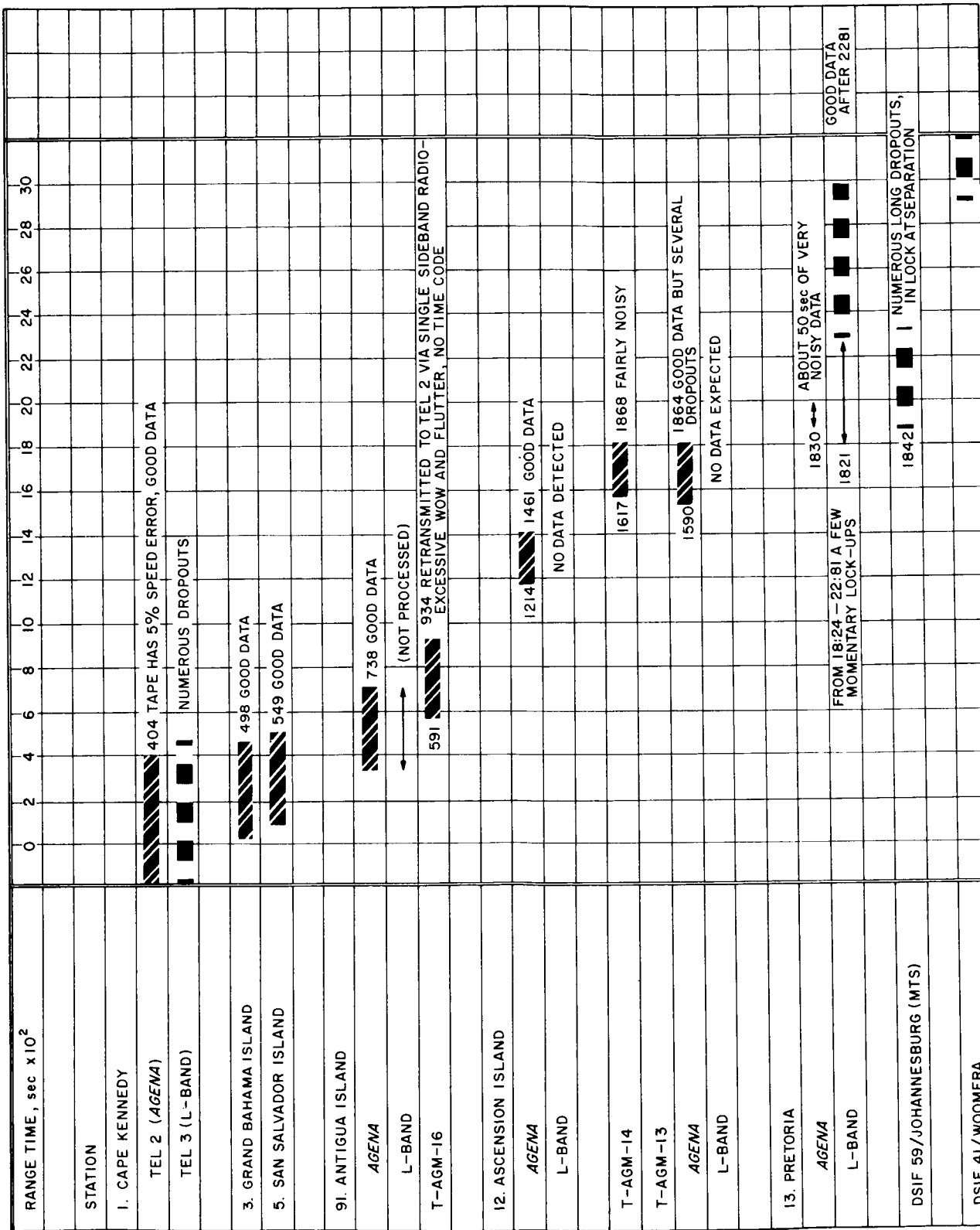
Agna discreets were covered in real-time by the following stations:

Mark 7	Cape and Antigua
Mark 8	Cape and Antigua
Mark 9	Sword Knot and Rose Knot
Mark 10	Sword Knot and Rose Knot
Mark 11	(exact time not confirmed)
Mark 12	Pretoria
Mark 13	Pretoria

c. Spacecraft coverage. In general, the telemetry tapes provided by AFETR were satisfactory with certain exceptions as discussed below. The telemetry coverage provided by these tapes is shown in Fig. 37. It was shown that *Agna* telemetry was very noisy at the time of electrical disconnect (Mark 11) and spacecraft/*Agna* separation (Mark 12); the latter was a Class I requirement. As a result, the Mark 11 was not verified and Mark 12 was uncertain, although the latter was observed on spacecraft gyro data recorded at DSIF-59.

As in the previous *Ranger* missions, better spacecraft telemetry data were recovered from the *Agna* telemetry sub-carrier Channel F, 98 kc, than by the spacecraft

³Tracking ships, known formally as Whisky, Victor, and Yankee, respectively.



SHIP NOMENCLATURE AND LOCATION:
T-AGM-16 (COASTAL CRUSADER) = T-AGM-14 (ROSE KNOT) = T-AGM-13 (SWORD KNOT) =
RIS 1851 (WHISKEY) AT 14°N 47°W RIS 1850 (VICTOR) AT 10°S, 6°E RIS 1852 (YANKEE) AT 20°S, 5°E

Fig. 37. Ranger VII launch telemetry coverage

L-band link, prior to electrical disconnect. The *Ranger VII* data which were retransmitted to the Cape Tell 2 station from down range via signal-side band radio were much superior to that of *Ranger VI*. This was due to the fact that *Agena* Channel F signal was used on *Ranger VII* while the L-band signal was used on *Ranger VI*. The best of these (from Ascension) had some frequency shift which caused the binary channels to be clipped off.

The problem areas encountered during the JPL processing of these telemetry tapes are summarized by the following:

1. Late acquisition by AFETR Station 13 (Pretoria) for *Agena* was caused by the operators tracking in a ground-antenna side lobe for approximately 6 min. L-band coverage by Station 13 was sporadic in the pass, while DSIF-59

went in and out of two-way lock several times, each time causing AFETR Station 13 to drop lock.

2. *Gemini* time code recorded on Rose Knot tape. (This was the only time code on the ship, and no other commitment was made.)

3. Tel-2 launch tape had tape speed error.

4. No data were detected on the re-transmission tape from Antigua to Pretoria.

5. The retransmitted data tape from Coastal Crusader had excessive wow and flutter.

6. No data were detected on the L-band tape track from Ascension or Sword Knot. AFETR reported that Ascension did track L-band, but Sword Knot was not expected to track on the launch azimuth flown.

IV. RANGERS VIII AND IX MISSIONS

A. Flight Plan

The *Rangers VIII* and *IX* (Fig. 38) were the final two missions of the *Block III* Project and of the *Ranger* series. The missions were conducted February 17-20 and March 21-24, 1965, respectively, with each spacecraft being launched from Complex 12 at the Air Force Eastern Test Range (AFETR), Cape Kennedy, Florida. The early portions of these flights were supported by the downrange tracking and telemetry stations and other facilities of the AFETR. Space-flight operations during the missions were supported by the JPL Deep Space Network.

The primary scientific objective of these flights, to obtain close-up high-resolution television pictures of the lunar surface, was met in each case. Basic engineering objectives of the missions were identical to those of the other *Block III Ranger* flights and were concerned with experiments involving trajectory correction (midcourse maneuver); terminal attitude maneuver; and the further development of spacecraft technology through performance evaluation of the *Ranger* spacecraft.

Ranger VIII impacted in Mare Tranquillitatis following a long sweep across the south-central lunar highlands.

Ranger IX impacted within 2.76 mi of the selected aiming point in the crater Alphonsus, achieving in the final pictures a photographic resolution of approximately 12 in. The flight plan for both missions was identical to that of *Ranger VII* which is illustrated and described in Chapter III of this report.

B. Ranger VIII Mission Synopsis

The spacecraft and the *Atlas/Agena* launch vehicle lifted off at 170500.795, February 17, 1965, following a smooth countdown. Performance of the launch vehicle was satisfactory with injection into a nominal trajectory occurring at 172736.8. Earth and Sun acquisition were accomplished within nominal times. DSIF-71, having acquired the spacecraft in two-way lock at L - 42 min, remained in this mode through launch and tracked the spacecraft to the local horizon.

Pre-midcourse data indicated that *Ranger VIII* would pass by the trailing edge of the Moon at a closest approached distance of 1136 mi. It was therefore decided to perform a midcourse maneuver which was executed at approximately L + 17 hr. *Ranger VIII* performed the maneuver as commanded. Sun and Earth re-acquisition

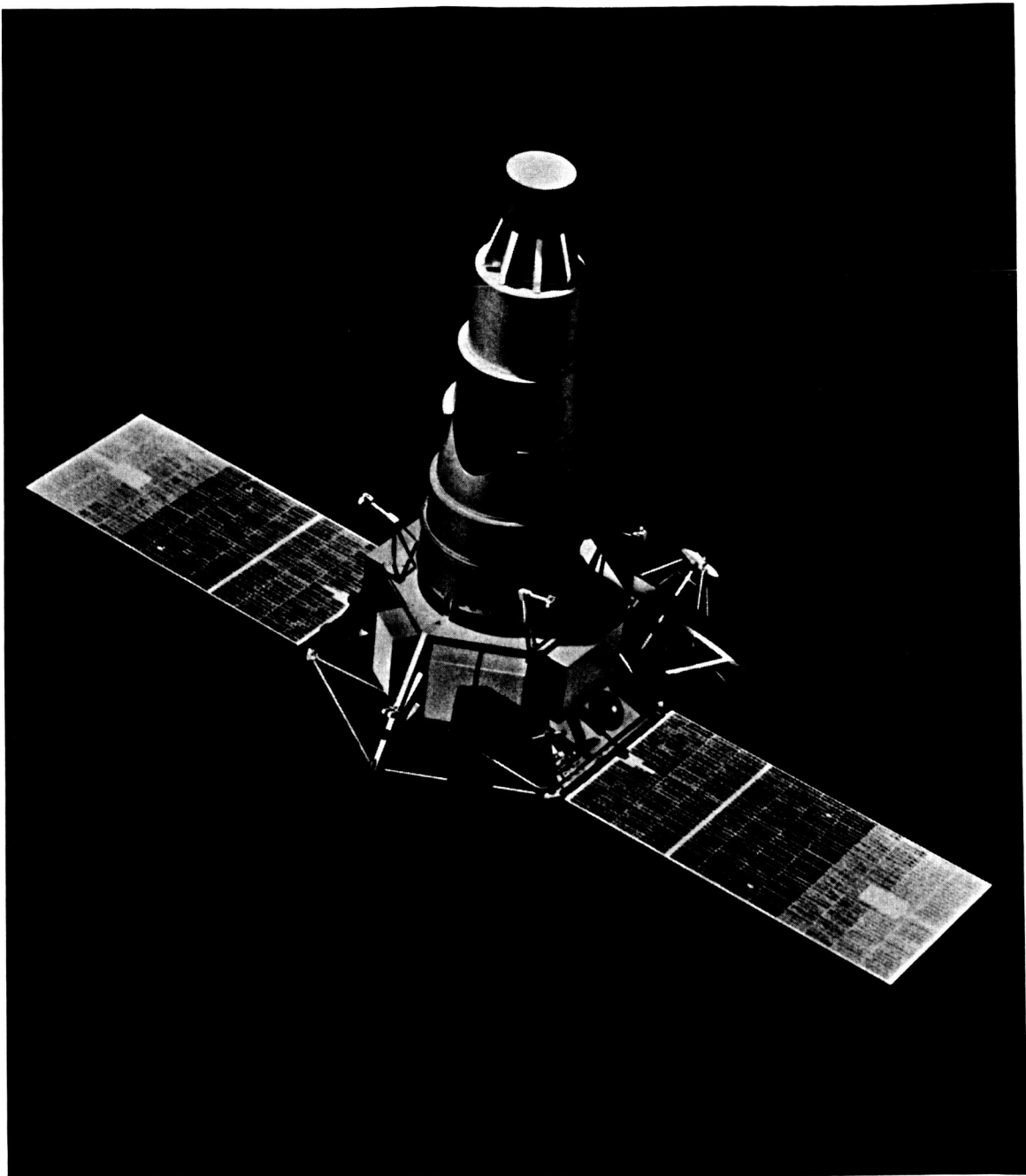


Fig. 38. Rangers VIII and IX spacecraft configuration

occurred within nominal times. The Earth track of *Ranger VIII* during this period is shown in Fig. 39.

Based on the spacecraft position, it was determined that a terminal maneuver would not be required. At 093309, February 20, 1965, the F- and P-Channels (full-scan and partial-scan television channels) indicated warm

up. At 093430 both channels indicated full power and DSIF-11 and -12 (Pioneer and Echo) began receiving TV pictures of the Moon's surface. The Goldstone DSIF stations received pictures from all cameras on both channels continuously to lunar impact. A total of 7137 pictures were received and recorded. At 095738, the spacecraft impacted the Moon at selenographic 2.6 deg North

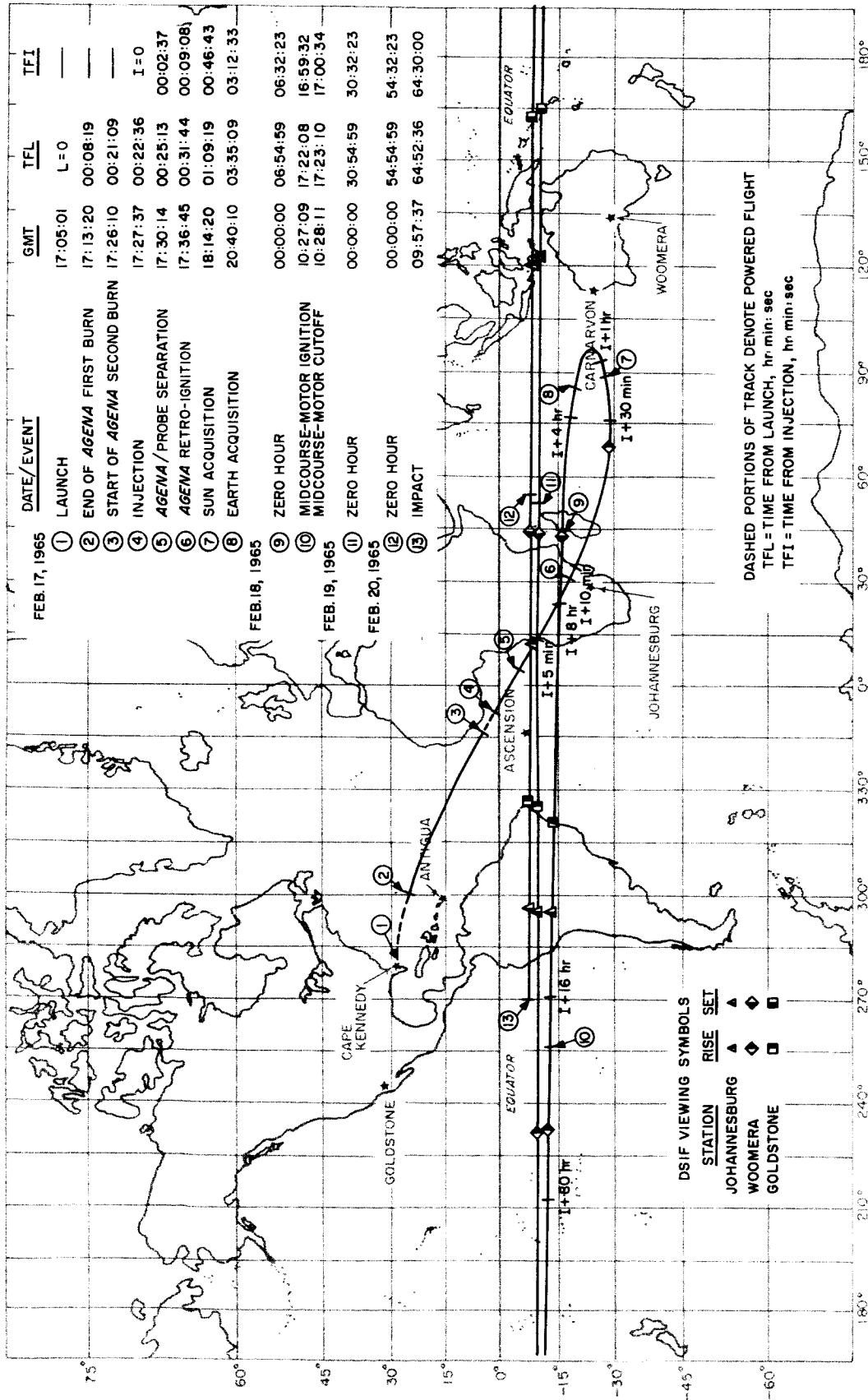


Fig. 39. Ranger VIII Earth track

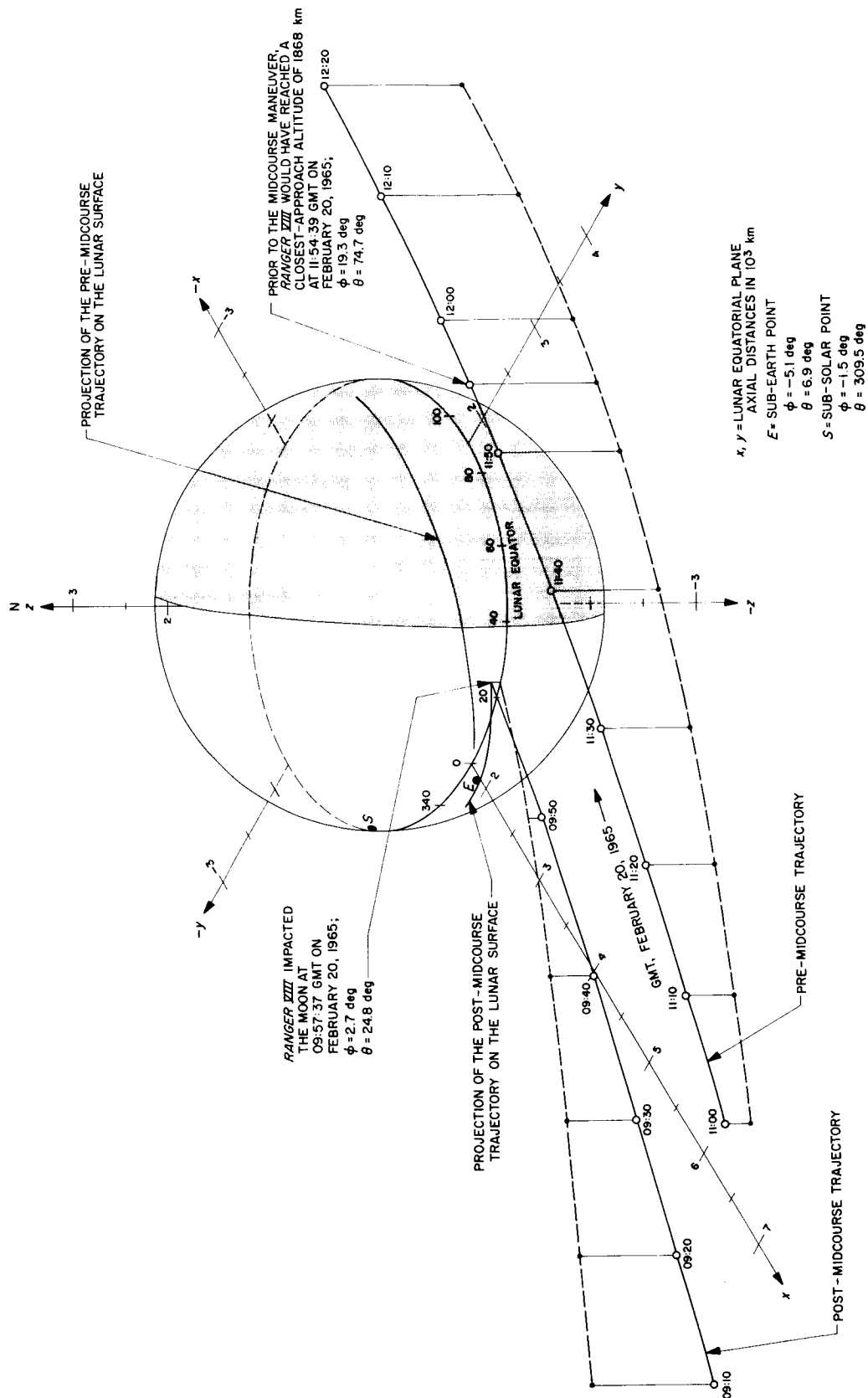


Fig. 40. Ranger VIII pre- and post-midcourse maneuver trajectories near the Moon and impact sites

latitude and 24.8 deg East longitude. The pre- and post-midcourse trajectories near the Moon and the impact sites are shown in Fig. 40.

C. Ranger IX Mission Synopsis

Following a normal countdown, *Ranger IX* liftoff occurred at 213702.456 on March 21, 1965. The launch period had been reduced to this one day, initially to obtain a desirable lunar target, and secondly to accommodate the scheduling of *Gemini* mission GT-3. Launch-vehicle performance was excellent, and the spacecraft was injected into a nominal lunar-transfer trajectory at 214948.3. DSIF-71 at Cape Kennedy maintained two-way lock with the spacecraft from prior to liftoff until the vehicle passed below the local horizon at $L + 465$ sec.

Orbit data acquired to midcourse indicated that *Ranger IX* would impact the Moon approximately 400 mi due north of the target, the crater Alphonsus; therefore, a midcourse maneuver was performed. *Ranger IX* executed the maneuver as commanded at ap-

proximately $L + 38.5$ hr. Sun and Earth re-acquisition occurred within the nominal times. The Earth track of *Ranger IX* during this period is shown in Fig. 41.

The terminal maneuver required to align the camera axis with the spacecraft velocity vector was performed as commanded, starting 65 min prior to impact ($I-65$ min). At 134814, March 24, 1965, the full- and partial-scan television channels indicated warm-up. At 134934, both channels indicated full power and the DSIF-11 and -12 began receiving television pictures of the surface of the Moon. The Goldstone DSIF stations received 5814 television pictures from all cameras, which operated continuously to lunar impact at 140820. Impact occurred in the crater Alphonsus at a selenographic latitude of 13.1 deg south and a longitude of 2.4 deg west. The pre- and post-midcourse trajectories near the Moon and the impact sites are shown in Fig. 41.

D. DSIF Configuration

The DSIF configuration for the *Rangers VIII* and *IX* missions was essentially the same as that for *Ranger VII*.

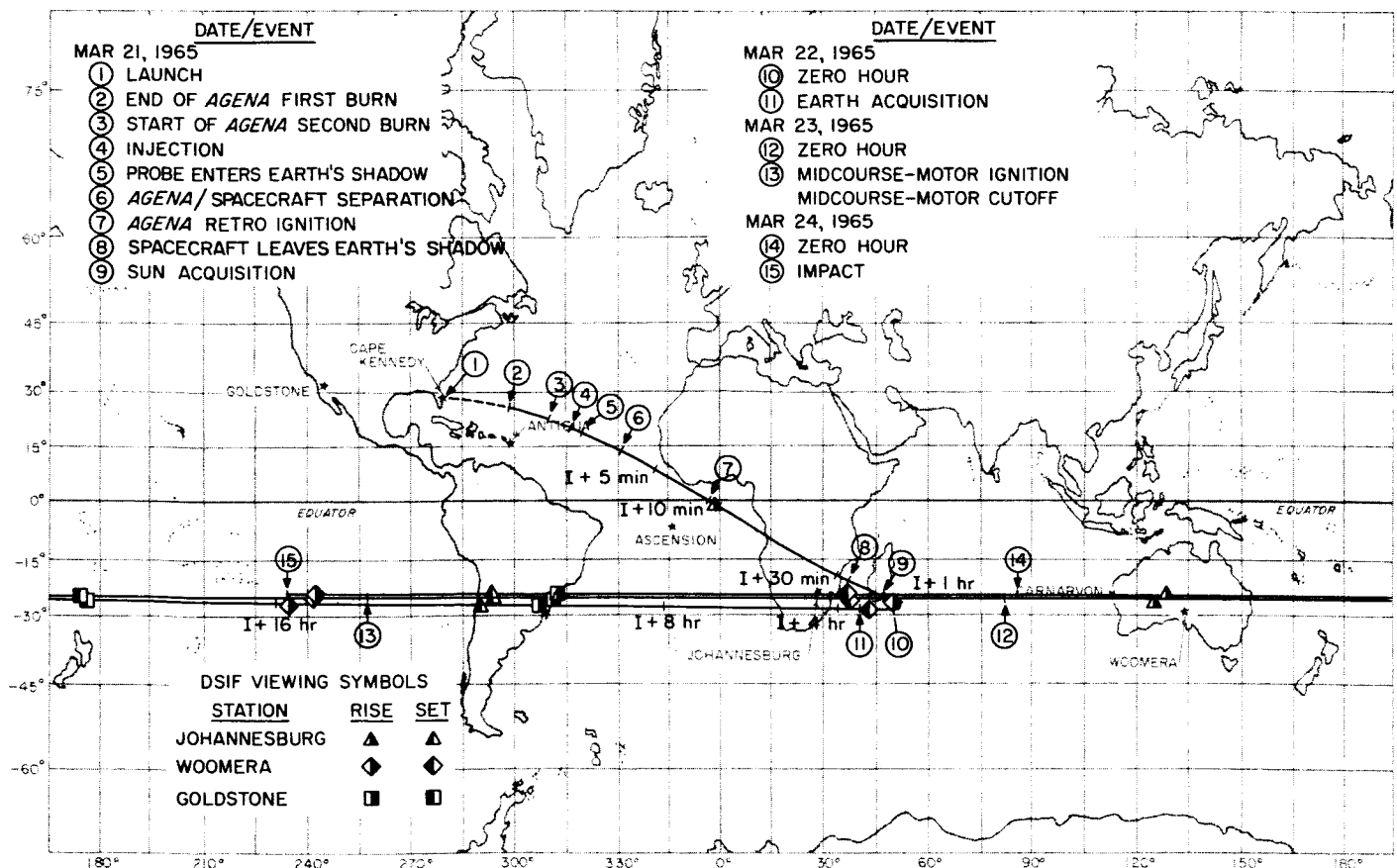


Fig. 41. Earth track of *Ranger IX*

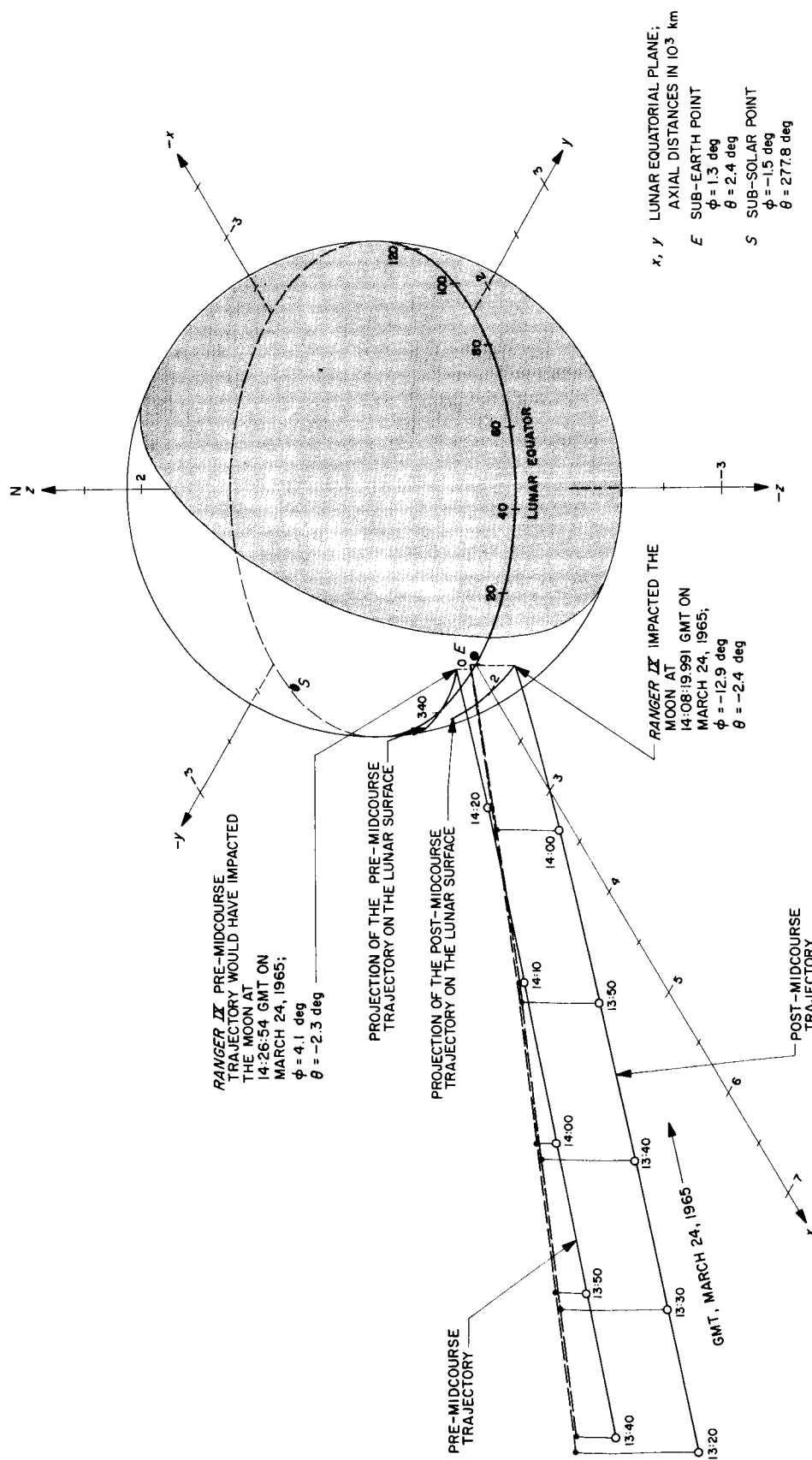


Fig. 42. Ranger IX pre- and post-midcourse maneuver trajectories near the Moon and the impact sites

Table 14. DSIF Capabilities and characteristics for *Rangers VIII* and *IX*

	DSIF 71 Launch Station	DSIF 59 Mobile Tracking Station	DSIF 11 Goldstone Pioneer Station	DSIF 12 Goldstone Echo Station	DSIF 41 Woomera Station	DSIF 51 Johannesburg Station
1. Antenna size	6-ft (Az-El) (No angle data)	10-ft (Az-El)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)	85-ft Polar (HA-Dec)
2. Maximum angular rate	Manually operated	20 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes	0.7 deg/sec in both axes
3. Antenna gain (960 Mc) tracking feed Horn feed	— 20.5 db	25.8 db \pm 0.75 —	— 45.7 db \pm 0.8	— 45.7 db \pm 0.8	43.7 db \pm 0.9 ^{a, b} —	43.7 db \pm 0.9 ^a —
4. System noise temp in °K or noise figure	1000 \pm 100°K	7.2 +0.5 db —1.2 db	95 +35°K —15°K	110 \pm 30°K	240 +25°K —65°K	240 +25°K —65°K
5. Transmission power, w	25 w	25 w	—	200 w (50 w backup)	200 w	200 w
6. Data transmission a. Angles-doppler b. Telemetry	— Real time ^d	Near-real time None	Record TV only	Near-real ^c time Near-real time Real time ^d	Near-real time Near-real time Real time ^d	Near-real time Near-real time Real time ^d
7. Decommuted telemetry	No	No	No	Yes	Yes	Yes
8. Command capability	No	No	No	Yes	Yes	Yes
9. Air freight time to JPL	2 days	7 days	1 day	1 day	7 days	7 days

^aThese values are subject to change pending measurement because of presence of tone due to L/S configuration.
^bWith GSDS feed; 44.4 db \pm 1.0 with Blue Scout Junior Tracking Feed (non-GSDS).
^cAngle data not the result of autotrack operation.
^dSent to the Telemetry Processing Station (TPS) via wide-band telephone line.

The network consisted of four permanent DSIF stations (-11, -12, -41, and -51); and Spacecraft Monitoring Station at Cape Kennedy (DSIF-71). A block diagram of each station configuration is shown in Fig. 25-30. While these diagrams primarily reflect *Ranger VII* support configuration, changes made for *Rangers VIII* and *IX* support are also noted. Table 14 shows the DSIF capabilities and characteristics for *Rangers VIII* and *IX*.

E. DSIF Preparation for *Rangers VIII* and *IX* Missions

Prior to the *Rangers VIII* and *IX* missions and their associated operational readiness testing, a series of calibration and checkout tests were performed at each station.

These tests consisted of comprehensive system and sub-system checks to ensure compatibility, reliability, and operator proficiency. Pre-mission tests, designed to exercise the station configuration after modifications associated with the *Mariner* Mars and *Ranger* missions, were performed at the overseas stations. A series of operational readiness tests to exercise components of the entire Space Flight System was concluded just prior to launch. Table 15

provides a summary of tests conducted by the DSIF prior to the *Rangers VIII* and *IX* missions.

For the *Ranger VIII* and *IX* missions, three DSIF stations were instructed to convert their RF systems and station configuration to L-band. These stations were DSIF-11, DSIF-41, and DSIF-51. The conversions at DSIF-41 and DSIF-51 were completed several days prior to the missions, thus allowing tests of the stations in the *Ranger* L-band configuration prior to launch. However, the conversion at DSIF-11 was not scheduled for completion until approximately 6 hr prior to the spacecraft impact on the Moon. Consequently, no test time was available. Figure 43 shows an external view of the DSIF-11 Pioneer station.

In general, the only difficulties experienced were in the areas of procedures and in test data simulation. During the *Ranger VIII* pre-launch countdown DSIF-51 reported two failures, but both were corrected prior to launch. DSIF-41 reported a switch failure in the antenna system during *Ranger IX* prelaunch countdown. The switch was replaced and the system rendered operational prior to launch. There were no such problems experienced during the missions.

Table 15. Summary of DSIF station tests for Rangers VIII-IX

Test	Date	On station	Test start	Phase	Pacific standard time	GMT	Simulated launch day	Duration	DSIF station	Track times
AT-3 SDAT acceptance	Jan. 5, 1965	10:00 a.m.	6:30 a.m. 10:00 a.m.	I. L — 1 hr to L + 4.5 hr II. L — 1 hr to L + 4.5 hr	6:30 a.m.-12:00 n 4:30 p.m.-10:00 p.m.	1430-2000 0030-0600	2/23/65 2/23/65	12 hr		
AT-4 FPAC acceptance	Jan. 7, 1965	10:00 a.m.	10:00 a.m.		10:00 a.m.- 4:30 p.m.	1800-0030	2/17/65	6.5 hr		
AT-5 DSIF 51 acceptance	Jan. 11, 1965	9:30 p.m.	10:00 p.m.	M/C — 3 hr to M/C + 1 hr	10:00 p.m.- 3:30 a.m.	0600-1100		5 hr	51	1 TTY 0200-0500 3 TTY, 1 Voice, 1 DATA 0500-1100
AT-6 DSIF 12 acceptance	Jan. 14, 1965	9:00 a.m.	9:00 a.m.	M/C — 3 hr to M/C + 1 hr	9:00 a.m.- 2:00 p.m.	1700-2200		5 hr	12	1 TTY 1300-1600 3 TTY, 1 Voice, 1 DATA 1600-2200
AT-7 DSIF 41 acceptance	Feb. 3, 1965	2:30 p.m.	2:30 p.m.	M/C — 3 hr to M/C + 1 hr	2:30 p.m.- 7:30 p.m.	2230-0330		5 hr	41	1 TTY 2030-2130 3 TTY, 1 Voice, 1 DATA 2130-0330
AT-8 comm. procedures	Jan. 22, 1965	10:00 a.m.	10:00 a.m.	I. Station 12 command transmission II. Station 41 command transmission III. Station 51 command transmission	10:00 a.m.- 4:00 p.m. 4:00 p.m.-10:00 p.m. 10:00 p.m.- 4:00 a.m.	1800-2400 0000-0600 0600-1200		6 hr 6 hr 6 hr 18 hr	12 41 51	1 TTY 1600-1700 2 TTY, 1 Voice 1700-2400 1 TTY 2200-2300 2 TTY, 1 Voice 2300-0600 1 TTY 0400-0500 2 TTY, 1 Voice 0500-1200
IT-1 SFOF integration	Jan. 12, 1965	8:45 a.m.	9:00 a.m.	L + 10.5 hr to M/C + 1.5 hr	9:00 a.m.- 4:00 p.m.	1700-2400	2/17/65	7 hr		
IT-2 SFOF integration	Jan. 18, 1965	9:00 a.m.	9:00 a.m.	L — 1 hr to L + 5.5 hr	9:00 a.m.- 3:30 p.m.	1700-2330	2/22/65	6.5 hr	12	2 TTY 1630-2330 1 Voice 1630-2330
IT-3 SFOF DSIF integration	Jan. 25 (PST) Jan. 26, 1965 (GMT)	7:00 p.m.	7:00 p.m.	I. L — 1 hr to M/C + 1 hr II. L — 3 hr to Impact	7:00 p.m.- 1:00 p.m. 1:30 p.m.- 4:30 p.m.	0300-2100 2130-0030	2/23/65	18 hr 3 hr 21 hr	51 41 12	0425-1609 0537-0655 1441-0030
IT-4 SFOF DSIF integration	Feb. 1 (PST) Feb. 2, 1965 (GMT)	5:00 p.m.	5:00 p.m.	I. L — 1 hr to M/C + 1 hr II. L — 3 hr to Impact	5:00 p.m.-11:20 a.m. 11:50 a.m.- 2:50 p.m.	0100-1920 1950-2250	2/18/65	18 hr 3 hr 21 hr	51 41 12	0247-1636 0310-0856 1501-2300
VT-1 OPS readiness	Feb. 8, 1965	7:30 a.m.	8:00 a.m.	I. L — 30 min to L + 1 hr II. L — 30 min to L + 4 hr III. M/C — 2 hr to M/C + 0.5 hr IV. L — 3 hr to Impact	8:00 a.m.- 9:30 a.m. 9:45 a.m.- 2:16 p.m. 2:30 p.m.- 5:00 p.m. 5:30 p.m.- 8:30 p.m.	1600-1730 1745-2216 2230-0100 0130-0430	2/17/65 2/17/65	12.5 hr	ETR ETR 51 41 12 12	
VT-2 OPS readiness	Feb. 12, 1965	8:45 a.m.	9:05 a.m.	I. L — 30 min to L + 1 hr II. L — 30 min to L + 4 hr III. M/C — 2 hr to M/C + 0.5 hr IV. L — 3 hr to Impact	9:05 a.m.-10:35 a.m. 10:50 a.m.- 3:30 p.m. 3:45 p.m.- 6:15 p.m. 6:45 p.m.- 9:45 p.m.	1705-1835 1850-2330	2/18/65 2/18/65	12.5 hr	ETR ETR 51 41 12 12	
Simulated launch	Feb. 15, 1965			L — 5 hr to L + 1 hr			2345-0215 0245-0545		ETR	(NO DSIF)

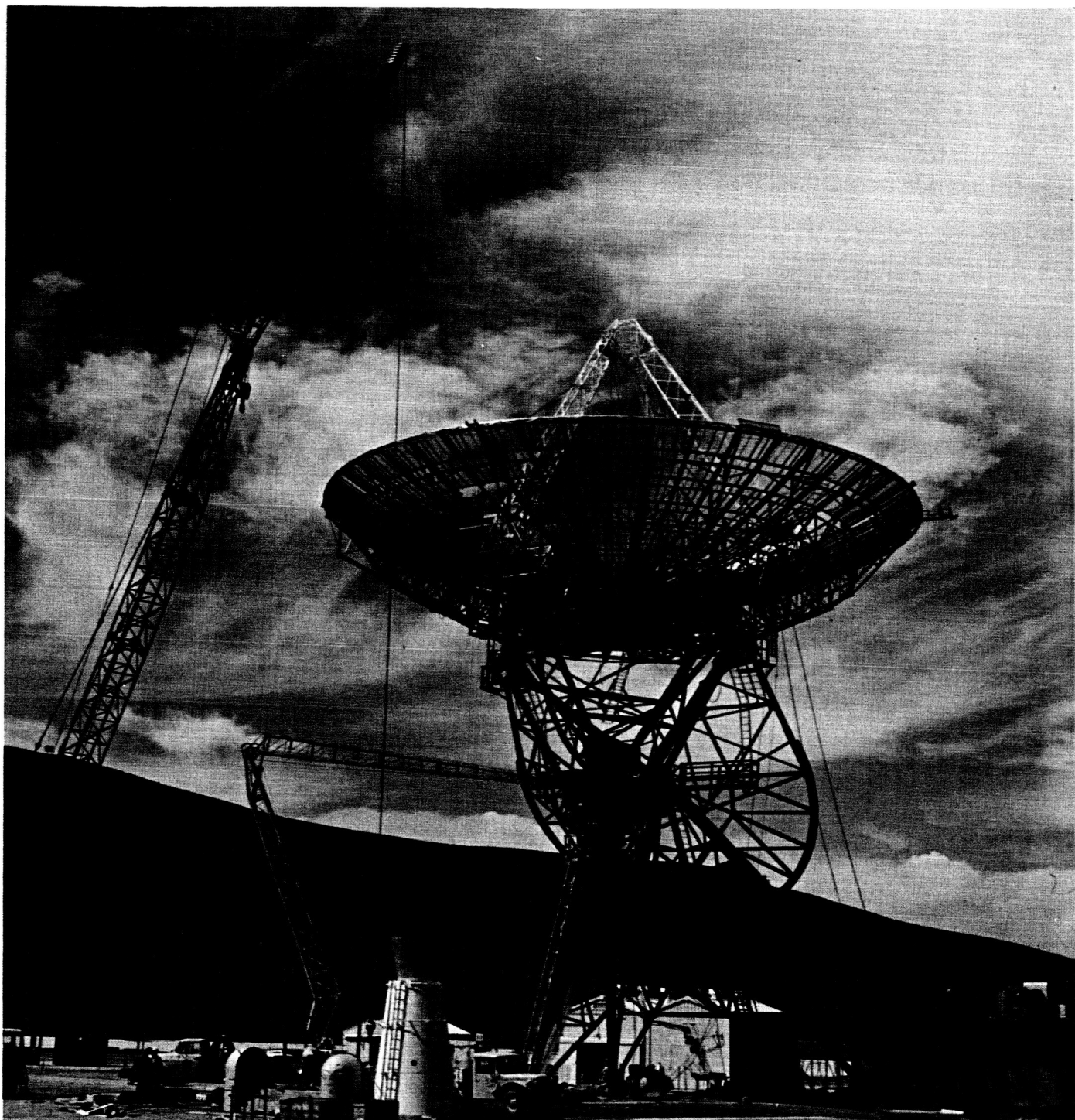


Fig. 43. DSIF-11, Pioneer station, Goldstone

F. Ranger VIII Tracking Operations

1. Launch to Injection

The Spacecraft Monitoring Station DSIF-71 acquired the spacecraft in two-way lock 42 min before launch for telemetry reception and possible command at 1605 on February 17, 1965. RWV modulation was on and the spacecraft signal level was -90 dbm. At liftoff the receiver signal level at DSIF-71 was -80 dbm. Except for a momentary dropout at 170721, DSIF-71 maintained lock until the horizon at 171243. The initial signal level of -80 dbm dropped off to -105 dbm by $L + 10$ sec because of changes in vehicle attitude. As the vehicle rose higher, the level increased to -95 dbm and remained approximately at this point until booster engine jettisoned. As in past operations, momentary dropouts were noted at this time. The signal level then decreased gradually to -115 dbm just prior to shroud separation. An increase to -110 dbm occurred following the normal transients as the shroud moved away from the spacecraft. From this point, the signal decayed gradually to -130 dbm at the horizon.

A preliminary analysis of vehicle trajectory data, real-time flight events, and vehicle systems data indicated that first and second stage vehicle flight performance was near nominal. The *Agna* and *Ranger VIII* spacecraft were successfully placed in a parking orbit during the initial *Agna* burn period.

2. Injection to Midcourse Maneuver

The DSIF-51 station at Johannesburg had been instructed to acquire the spacecraft in the two-way mode as early as possible. This was accomplished by turning the transmitter at the station on to the 2-w level prior to the spacecraft rise above the horizon. The spacecraft transmitter was first acquired at 173330. The signal level at acquisition was reported at -90 dbm. Indications were that it was in two-way lock at that time. DSIF-51 had turned on their transmitter at 172751 and achieved spacecraft lock as soon as acquired. The transmitter remained on to 175125. At this time, the decision was made to momentarily drop lock with the spacecraft and reacquire. The transmitter was turned back on at 175149. The decision to drop lock and reacquire was made to assure that the spacecraft was not in a false lock. When the ground transmitter was turned back on and the data analyzed, indications were that the spacecraft had been in proper two-way lock throughout the entire period. The tracking data derived from this early period of time were extremely valuable in generating a high-quality orbit.

At 1752, the DSIF-41 station at Woomera acquired the spacecraft transmitter and reported a signal level of -130 dbm. A series of transfers of two-way lock were executed between Woomera and Johannesburg at the request of the SFOD. A momentary drop of lock was experienced in these transfers when the receivers at the stations were switched from the two-way to the three-way mode.

At 2125, DSIF-51 transmitted the antenna-changeover command (RTC-3). When the spacecraft responded to the receipt of this command, the received signal strength at the DSIF stations-41 and -51 increased from -115 dbm to -107 dbm.

3. Midcourse Maneuver to Impact

DSIF-12 at Goldstone acquired the spacecraft in one-way lock at 055729 on January 18, for their first pass. The signal level at acquisition was reported at -140 dbm, but by 060501 the signal level had increased to -109.5 dbm. At 100000 on the 18th of January, RTC-4, the initiate midcourse command, was transmitted to *Ranger VIII*. The stored commands, SC-1, -2, and -3 had been transmitted and verified as correct; at this point everything with the spacecraft and the DSIF station looked quite normal. Shortly after the transmission of RTC-4, the signal strength of the spacecraft dropped to a very low level—slightly above threshold. It remained at this level fluctuating occasionally to as high as -155 dbm until the scheduled time for motor burn, at which time the signal suddenly jumped to the expected value for the maneuver. This anomaly is still being investigated; however, analysis of DSIF data indicates that no problems at the station were encountered. The spacecraft continued in a relatively uneventful cruise mode with acquisitions and transfers at the DSIF stations occurring normally. Post-maneuver tracking data analysis confirmed indications of a successful midcourse maneuver.

As discussed elsewhere in this Report, it was decided to send an RTC-6 (terminal maneuver) and an RTC-8 (attitude control disconnect) to provide an additional backup turn-on command for the TV subsystem. The RTC-6 was transmitted to the spacecraft at 093309 on February 20, 1965, by DSIF-12.

DSIF-12 was prepared to transmit RTC-7 backup turn-on commands in the event of failure in the timing systems in the spacecraft. Both F and P channel video came on with full power as scheduled, but the RTC-7

was retained in the command system until impact, in the event that the television should turn off for some reason. Reception of video at both DSIF-12 (Echo) and DSIF-11 (Pioneer) was of excellent quality with all systems functioning properly. Figures 44 and 45 show two of the lunar photographs relayed to the DSIF stations by the *Ranger VIII* spacecraft.

4. Station Tracking Operations

DSIF tracking periods, together with nominal view periods, are presented in Table 16. Ground commands sent to the *Ranger VIII* spacecraft by the DSIF are shown in Table 17. A detailed account of tracking operations at each station is provided in the following paragraphs.

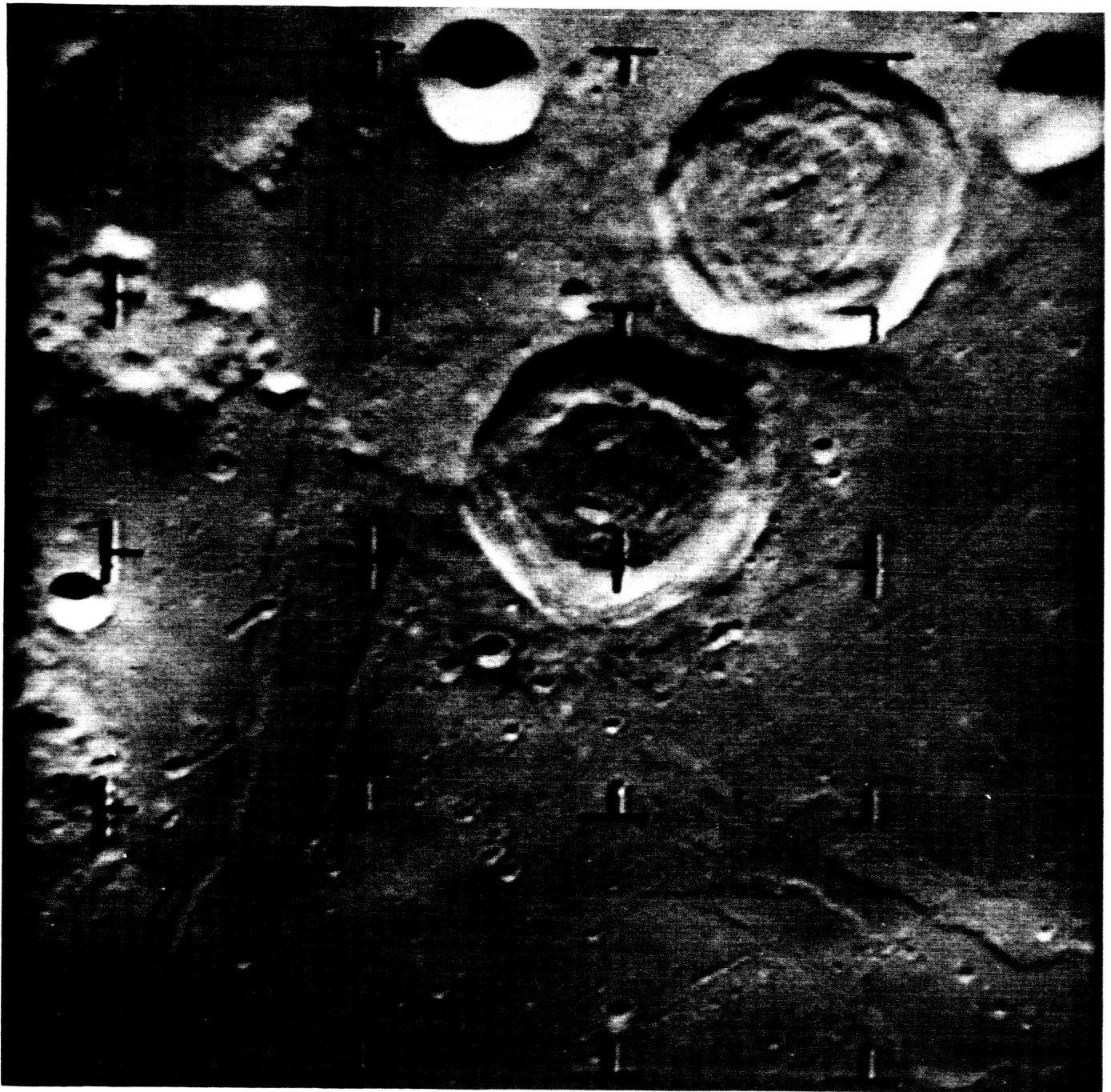


Fig. 44. *Ranger VIII* lunar photograph (frame 27A)

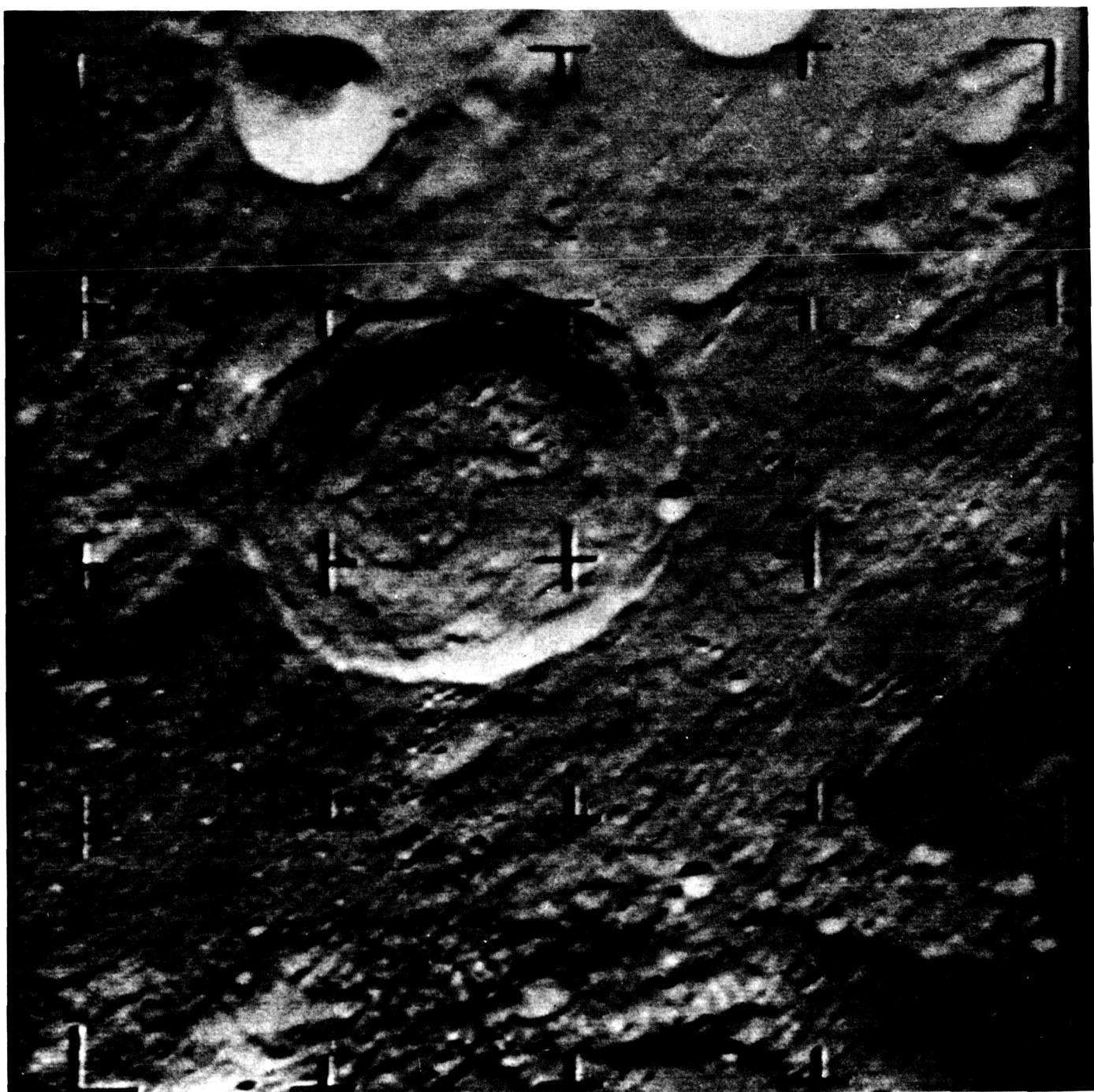


Fig. 45. Ranger VIII lunar photograph (frame 81B)

a. DSIF-71, spacecraft monitoring station. The station acquired the spacecraft in two-way lock at L - 42 min (1605). The RWV modulation was on at this time and the spacecraft signal level was approximately -90 dbm. The transmitter VCO was offset from 29.668190 Mc to 29.668690 Mc at L - 20 min for the doppler offset.

Ground receiver loop-noise bandwidth was 150 cps and the AGC time constant was 0.3 sec.

The received signal level at liftoff was -80 dbm. The ground receiver suffered a momentary loss of lock at 170721. The receiver then maintained good lock until

Table 16. Nominal^a view periods and actual^b DSIF tracking periods for *Ranger VIII*

Date	DSIF station	Pass no.	Nominal rise (GMT)	Nominal set (GMT)	Nominal view period	Acquisition by station	Loss of signal by station	Actual view period
February 17, 1965	71	Launch	Launch	171232	07M30S	170501	171250	07M45S
	51	1	173250	072500 ^c	13H52M	173310	073759 ^c	14H04M
	41	1	175620	232900	05H33M	175502	001300 ^c	06H07M
February 18, 1965	12	1	060200	163100	10H29M	060700 055800 ^d	163000	10H23M
	41	2	122900	003400 ^c	12H05M	120500	005300 ^c	12H48M
	51	2	200400	075500 ^c	11H51M	195928	080055 ^c	12H01M
February 19, 1965	12	2	061300	170000	10H47M	061100 060500 ^d	165900	10H48M
	41	3	124300	004500 ^c	12H02M	122800	010200 ^c	12H34M
	51	3	201900	080200 ^c	11H43M	201600	080400 ^c	11H48M
February 20, 1965	12	3	061200	095738 ^e	03H45M	061400 060800 ^d	095738 ^e	03H43M

^aA nominal view period is calculated to include such land masks and antenna limits as will ensure that the spacecraft remains in the main beam, i.e., within 0.5 deg or approximately 3 db of the center of the main beam.

^bPeriod between first solid receiver lock and last drop of solid receiver lock; momentary drops are neglected.

^cSet occurs on next day after rise.

^dActual receiver lock.

^eImpact.

Table 17. Ground commands from DSIF to *Ranger VIII*

Command	Initiated (Date/GMT)	Verified (GMT)	DSIF station	TM event blips recorded at station	Command	Initiated (Date/GMT)	Verified (GMT)	DSIF station	TM event blips recorded at station
RTC-0	48/212100	212138	51	N/A	RTC-0	49/113000	113038	12	N/A
RTC-0	48/212300	212338	51	N/A	RTC-0	49/113200	113238	12	N/A
RTC-3	48/212500	212538	51	N/A	RTC-3	49/113400	113438	12	N/A
RTC-0	49/085000	085038	12	N/A	RTC-0	51/073700	073738	12	N/A
RTC-0	49/085200	085238	12	N/A	RTC-0	51/073900	073938	12	N/A
SC-1	49/085400	085438	12	B-20	SC-4	51/074100	074138	12	B-20
SC-2	49/085600	085638	12	B-20	SC-5	51/074300	074338	12	B-20
SC-3	49/085800	085838	12	B-20	SC-6	51/074500	074538	12	B-20
RTC-0	49/093600	093638	12	N/A	RTC-0	51/082300	082338	12	N/A
RTC-0	49/093800	093838	12	N/A	RTC-0	51/082500	082538	12	N/A
RTC-3	49/094000	094038	12	N/A	RTC-8	51/082700	082738	12	B-20
RTC-4	49/100000	100038	12	N/A	RTC-6	51/084730	084810	12	B-21

Real time commands

RTC-0 = Clear command

RTC-3 = Antenna switchover

RTC-4 = Begin midcourse maneuver

RTC-6 = Initiate terminal maneuver

RTC-8 = Maneuver override

Stored commands

SC-1 = Midcourse maneuver roll duration

SC-2 = Midcourse maneuver pitch duration

SC-3 = Midcourse maneuver velocity increment

SC-4 = Terminal maneuver first pitch duration

SC-5 = Terminal maneuver yaw duration

SC-6 = Terminal maneuver second pitch duration

the local horizon was reached at 171243. The telemetered AGC from the spacecraft transponder indicated a signal level of -90 dbm at liftoff. The signal was approximately -120 dbm at launch plus 4 min. The ground transmitter power was then increased 30 db. The transponder AGC then indicated a -90 dbm signal. Telemetry conditions during the launch phase were extremely good.

b. DSIF-51, Johannesburg. Launch and first passes, February 17-18, 1965. At 0605, 5 min after the start of

the countdown, it was found that the 50 kva, 400 cps motor generator supplying the transmitter had a burnt-out exciter armature. The standby unit was activated and the countdown proceeded without further incident until completions at 1610 with all systems in a state of mission readiness.

Liftoff took place at 170501 and 5 min before the spacecraft came over the horizon, the transmitter was switched

on at minimum power. The receiver in the C-2 position was able to lock on to a strong signal at 173320, servo went to autotrack at 173401 and the transmitter power was raised to 200 w at 173418.

Following a frequency change at 173554, the transmitter was switched off at 175124 on voice instructions from JPL. Two-way lock was again achieved at 175300, 1 min and 11 sec after the transmitter was switched on again. Event blips were observed between 1805 and 1808 and at 1825 transfer preparations began. With the DSIF-51 transmitter power down at 1828, 10 cps modulation from DSIF-41 was observed at 183204, and a transfer was successfully executed at 1833. The transfer back to DSIF-51 took place at 2000 and two RTC-0 commands followed by an RTC-3 command were transmitted, the last at 2125, to switch the spacecraft to the high-gain antenna. A subsequent transfer back to DSIF-41 was executed at 220100, DSIF-51 again taking over the spacecraft at 2320.

The transmitter was switched off at 062728 as DSIF-11 took over the spacecraft and tracking continued smoothly until the horizon. Loss of signal occurred at 073759.

Pass 2, February 18-19, 1965. The countdown began at 1000 and proceeded without incident to completion at 1600. During this period the re-wound 400 cps generator had been returned to service. The station acquired the spacecraft at 195928. Transfer from DSIF-41 took place at 233000. At 233340 servo went to aided track as the antenna was not following in HA. The transmitter was turned off at 233425, to be turned on again at 233620. Momentary drops of lock occurred while investigating the fault and after the receiver HA phase detector had been adjusted, servo was able to go to auto-track again at 004700. Transfer back to DSIF-51 was accomplished at 072005 and at 075053, DSIF-11 took over again, just prior to the spacecraft set on the local horizon at 080055 when the receiver dropped lock.

Pass 3, February 19-20, 1965. Station countdown began at 1100 and was completed at 1948. This pass started at 201545 with the receiver locked on to the -114.5 dbm spacecraft signal. Two-way lock was taken over from DSIF-41 at 204000 and passed back again at 220100.

At 0040 DSIF-51 again transferred to two-way, and tracking continued until the spacecraft was handed over to DSIF-11 at 063035 on the morning of February 20.

Servo reached pre-limits at 080139 and *Ranger VIII* set over the western horizon at 080508 when the receiver lost lock.

c. DSIF-41, Woomera. Launch and First Pass, February 17-18, 1965. Station countdown began at 0530 and was satisfactorily completed at 1430. Spacecraft was first acquired in RF lock with a -133 dbm signal level at 1752 through the acquisition aid antenna. At 1756 transfer to the main beam was accomplished. This transfer was delayed because the slow rate of rise constituted an appreciable time when the main beam signal was higher than the acquisition aid signal. The errors, however, were not such as to move the antenna out of limits and a switch to auto-track was made prematurely. Since this entire sequence lasted only about 25 sec, very little significant data were lost.

At 1825 10 cps modulation was observed in three bursts. The transmitter was turned on at 1832 at the 48-w level. Good two-way data were observed at this time. The transmitter level was then increased to 200 w. At 1850 a transmitter frequency counter failed and was replaced with an alternate.

DSIF-41 transmitter power was reduced at 1958 in preparation for a two-way transfer to DSIF-51 which was accomplished at 2000. The transmitter was turned off at 2001 and good three-way data were observed at 2005. The station again took over the signal from DSIF-51 at 2150. A short loss of receiver lock was experienced during the changing mode. The station transmitter was again increased to the 200-w level at 2200 with good two-way data observed 2 min later.

During a transmitter frequency change, the receiver went to bad data and suffered a momentary loss of lock. The receiver returned to good data at 2249. The station began preparations for a two-way transfer to DSIF-51 at 2315. Transmitter power was reduced and the transmitter was turned off at 2321. The receiver went to good three-way data after momentary loss of lock while changing modes. At 2327 the antenna went to pre-limits. The receiver went out of lock at 0013, some 46 min after loss of track.

Pass 2, February 18-19, 1965. Countdown for this pass began at 0500 and was completed at 1100. At 120350 the receiver locked on the spacecraft signal at -140.5 dbm through the acquisition aid antenna. Transfer to the main beam was made at 122740 and servo went to auto-track approximately 2 min later. Good angle data were observed during this period. At 1237 it was noticed that

the tape recorder timing had been missing since the beginning of the pass. The trouble was traced to a faulty patch which was replaced.

Equidistant measurement made with DSIF-12 at 1420 was at a signal level of -113.0 dbm. Two-way transfer procedures were started at 1455 and the transmitter level went to the 200 w level at 150139 with a frequency of 29.668309 Mc. Good two-way data were observed at this time.

At 1810, recorder A was stopped for a tape change and placed back in service by 1823. The transmitter frequency was changed to 22.668372 Mc at 2200. Good data were observed at 2205. Equidistant signal strength with DSIF-51 at 2211 was -112.8 dbm. At 2323, 10 cps modulation was applied and the transmitter was reduced to the 20 w level marking the beginning of the two-way transfer to DSIF-51. The transmitter was turned off at 2333 after observation of 10 cps modulation and the receiver went to three-way mode with lock being lost momentarily. Good three-way data were observed at 2342. The antenna went to prelimits at 0032 and the receiver lost lock 20 min later.

Pass 3, February 19 and 20, 1965. The third pass countdown began at 0530 and was completed at 1130. At 122719, the receiver was in lock with the -146 dbm signal from *Ranger VIII* through the acquisition aid antenna. The receiver went to the main beam at 1241 with servo going to autotrack three min later. Good three-way data were observed at this time. At 1255, 10 cps modulation was observed, and two-way transfer from DSIF-12 was accomplished at 130000 with the transmitter level increased to 200 w. Good two-way data was observed at this time.

At 1455, 10 cps modulation was applied, and two-way transfer to DSIF-12 began. The transmitter at 29.668257 Mc was reduced to the 22 w level. At 1500 the transmitter was turned off and a 10 cps burst observed. Good three-way data was observed. DSIF-12 equidistant signal strength was measured at -116.7 dbm. DSIF-41 again took over the signal from DSIF-12 at 1640 and the transmitter level was increased to 200 w 5 min later.

At 1759 tape recorder A was stopped for a tape change and placed back in service by 1810. The transmitter frequency was changed to 29.668300 Mc at 1938. One min later the receiver was found to be locked on a side-band and this situation was rectified at 1940. Two-way transfer to DSIF-51 began at 2035 with 10 cps modulation being

applied. The transmitter power was reduced to 20 w at 2038 and 10 cps modulation observed 2 min later. Good three-way data were observed at this time.

DSIF-41 again took over the *Ranger VIII* signal from DSIF-51 at 220000 with the transmitter frequency at 29.668311 Mc. Equidistant signal level between the stations was measured at -116.4 dbm. The signal was again handed back to DSIF-51 at 0041 and good three-way data were observed. The antenna went to mechanical prelimits at 0043 and the telemetry threshold was reached 15 min later at 0058. The receiver went out of lock at 0102 marking the end of the *Ranger VIII* mission for DSIF-41. Figure 46 shows a view of the station antenna and operations buildings.

d. DSIF-12, Echo, Goldstone. Launch Pass, February 17, 1965. During the countdown, the transmitter/exciter back-up Manson synthesizer was erratic. The S-band synthesizer used as a primary unit was stable, and no attempt was made to work on the Manson at that time. Following launch, confirmation of injection, and DSIF-51 tracking in the two-way mode, DSIF-12 placed the station in a stand-by status until the start of the countdown for the first pass.

Pass 1, February 17 and 18, 1965. Prior to this pass, a C-22 module was replaced in the RWV to correct an error in the detection circuits. A 5 db change in the receiver subsystem was determined to be a shift in the AGC curve. A spare 455 kc IF amplifier was installed due to 1.1 v on the gas check with the original module. The maser/paramp gain was found to be 1.3 db high and was reset to the correct value. The AGC curve was flatter than normal at -163 dbm; however, threshold was -165 dbm.

One-way acquisition occurred at 055729 and two-way lock was confirmed at 052638. Equidistant measurements with DSIF-51/-12 were made at 065700 with a signal level of -108.7 dbm, and the AGC was -89 v. Equidistant measurements with DSIF-12/-41 were made at 142000 with a signal level of -112.95 dbm and an AGC voltage of -0.596 . Tracking conditions remained good until transmission of the RTC-4 initiate midcourse maneuver command at 100000. At 100231 the receiver went out of lock and hovered around threshold at -163 dbm until 102712.

The in/out of lock condition varied with such rapidity that it was difficult to record. On several occasions the signal level rose to -145 dbm and almost instantly dropped to below threshold. The receiver was tuned a few cycles at a time during these periods to maintain

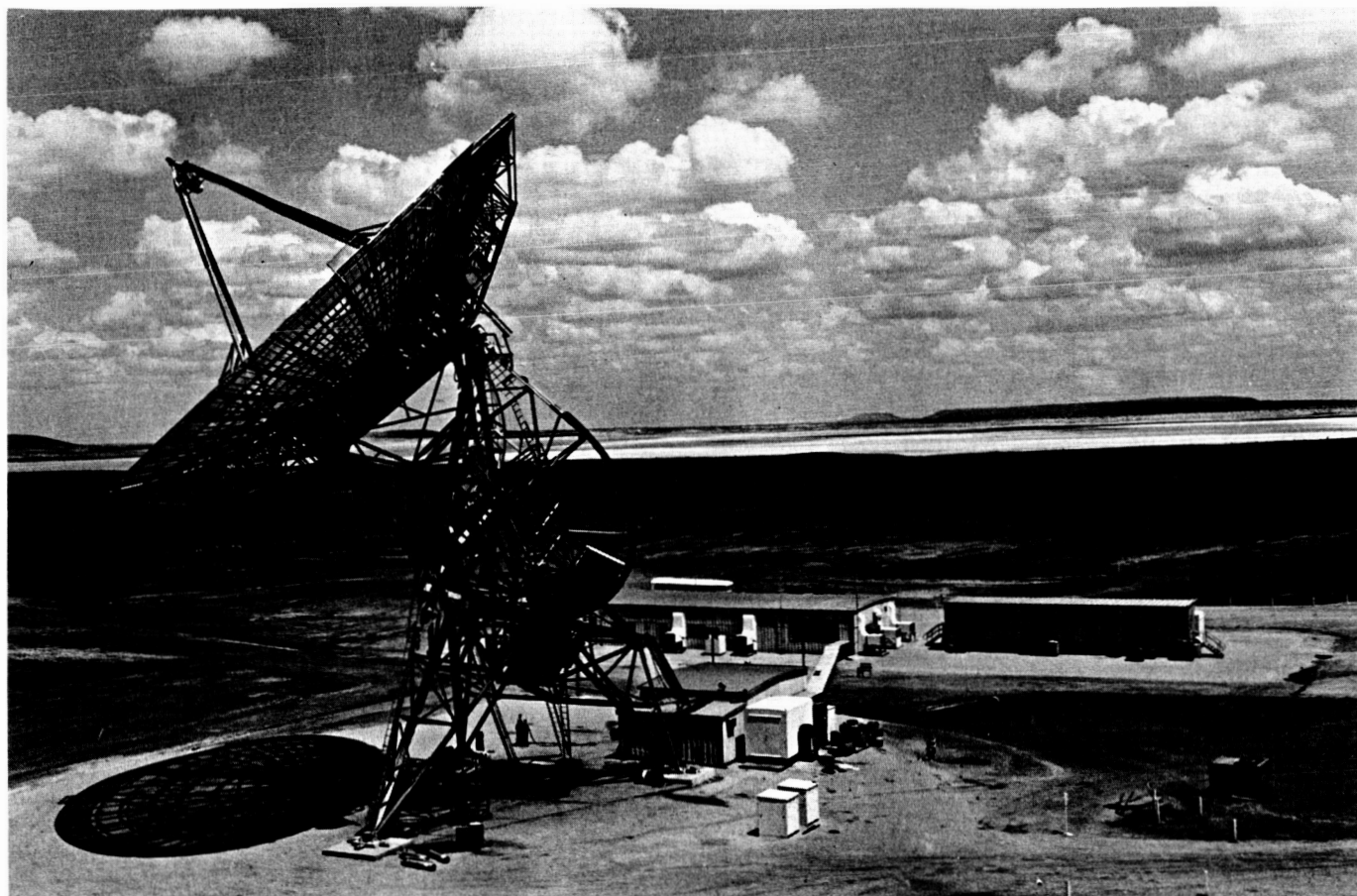


Fig 46. DSIF-41, Woomera station

the doppler count correct with predictions. Stability was again restored at 102712 with a signal level of -126 dbm slightly increasing to -122 dbm, at which level it remained until the RTC-3 antenna switchover command at 113400. The signal level decreased to -135 dbm and at 113540 increased to -112 dbm, remaining within 1 db of that level to the end of the first pass. The midcourse maneuver sequence began at 085000 with the transmission of the first RTC-0 and ended at 113440 with a switchover to the high-gain antenna.

The receiver was in 20 cps bandwidth during acquisition, changing to 60 cps at 061545 and back to 20 cps at 062734. The receiver changed to 60 cps bandwidth at 145545 and back to 20 cps at 150245 and remained so until the end of the first pass at 163000 when the transfer to DSIF-41 was completed. A reduction in transmitter power was experienced at 130445, dropping to 135 w at 130540. The power was adjusted to 200 w, and at 131355 increased to 235 w. It was readjusted to 200 w at 131615, remaining steady from thereon. The fluctuation was attributed to

the power generator, which was manually adjusted at the time and no further power fluctuations were experienced for the remainder of the mission. Servo subsystem changed to 0.05 cps bandwidth at 070850 for the remainder of the first pass.

While some abnormalities were experienced during the midcourse maneuver, telemetry conditions were essentially good for most of the first pass. The in/out of lock condition experienced between 100231 and 102712 made it difficult to maintain lock and synchronization. Telemetry operators used an extrapolation process to determine rate 3 and 4 synchronizations, and manually reset the equipment, when required to secure such telemetry data as were available when the receiver was in lock. The transmitter backup synthesizer failed during the first pass, and was replaced with an HP-5100A S-band synthesizer to provide backup for the one being used as a primary unit. The receiver experienced problems with the AGC, which were temporarily corrected; and caused no subsystem degradation during the mission.

Pass 2, February 18 and 19, 1965. The station count-down for this pass proceeded normally and the system was in a state of readiness at 033500. One-way acquisition occurred at 060519, and two-way lock was confirmed at 063025. Tracking conditions were good for the entire second pass.

Equidistant measurements with DSIF-51 were made at 161500 with a signal level of -118.2 dbm and an AGC voltage of -0.648 . A total of four transfers were accomplished during this pass. The first, to DSIF-51 at 072106, and back to DSIF-12 at 075039. The second, to DSIF-41 at 130035, and back to DSIF-12 at 150022. All transfers, including the second pass first and last transfers were accomplished with a minimum of difficulties. Coordination with both DSIF-51 and -41 via SFOF was excellent. Telemetry conditions were good throughout the entire second pass with all subsystems operating normally.

Pass 3, February 19 and 20, 1965. Prior to acquisition of the signal, an erratic VCO and a reference channel phase detector were replaced in the receiver. The AGC was balanced prior to completing the threshold checks. At 054425, the maser power supply became unstable and was replaced. Following the change, the maser gain was established at 10 db at 054804. A subsequent bandwidth check showed no degradation.

One-way acquisition occurred at 060743 and two-way lock was confirmed at 063020. Tracking conditions were good from acquisition to lunar impact at 095738. One equidistant measurement with DSIF-51 was made at 071448 with a signal level of -115.7 dbm and an AGC voltage of -0.828 . The terminal maneuver sequence began at 073700 with the transmission of the first RTC-0. Subsequent command transmissions to the spacecraft are shown in Table 17.

An RTC-8 was loaded into the RWV at 085237 and held until it was substituted with an RTC-7 at 092432. TV warmup was recorded by receipt of 90-point telemetry at 093309 and reception of full-power video on both channels began at 093434. Telemetry conditions were good throughout this pass.

At 072115 the ground receiver AGC changed from an indicated signal level of -117.4 to -112 dbm. Checks made of the system Low Noise Amplifier (LNA) indicated normal performance. Band pass measurements indicated normal band pass at the LNA gain; no video degradation was evident and telemetry was normal. No checks were

made of the receiver as it would have been necessary to drop lock with the spacecraft. The mission was successfully completed.

G. Ranger IX Tracking Operations

1. Launch to Injection

After several holds, caused by problems with the launch vehicles, liftoff occurred at 213702 on March 21, 1965. The DSIF-71 station at Cape Kennedy maintained two-way lock with the spacecraft from prior to liftoff until the vehicle passed below the local horizon at $L + 465$ sec. The expected momentary dropouts were again noted at booster engine jettison, followed by a return to normal signal level. The initial signal level at launch was -75 dbm. This decreased gradually to approximately -130 dbm just prior to loss of signal at the horizon.

DSIF-71 telemetry conditions were very good during the entire launch phase, and no data were lost. Real-time evaluation and subsequent analysis of the spacecraft telemetry indicated proper performance with no anomalies occurring during this phase.

2. Injection to Midcourse Maneuver

DSIF-51 was instructed to acquire while transmitting at the 2-w level in order to provide early two-way tracking data of high quality. Acquisition of the spacecraft in two-way lock was accomplished at 2201. The signal strength at acquisition was a nominal -93 dbm. DSIF-51 confirmed the acquisition of the Sun and Earth by the spacecraft at their nominal times.

Due to the launch characteristics and the position of injection chosen for this flight, the DSIF-41 view of the spacecraft consisted of a relatively short pass quite low over the local horizon. Consequently, the signal strength was quite low (-140 dbm) when the station acquired at 225208. Even though the signal strength was low, two-way transfer was initiated at 0004 on March 22; and two-way lock was confirmed almost immediately. Due to the low signal level, difficulty was experienced in maintaining lock at both DSIF-41 and DSIF-51, but this was expected and in no way affected the mission.

At 002520 the spacecraft was transferred back to DSIF-51. The RTC-3, antenna changeover command, was transmitted by DSIF-51 at 0930 (all commands transmitted to *Ranger IX* by the DSIF are shown in Table 19). A rise in the spacecraft signal level from -122.2 dbm to -109.8 dbm signified a successful antenna changeover.

DSIF-12 acquired the spacecraft for their first pass at 082410. Because of the high accuracy of the launch, it was decided to postpone the midcourse maneuver until the Goldstone second pass. As a result, DSIF-12 tracked the spacecraft in the cruise mode throughout their first pass, with only one anomaly being noted. The spacecraft receiver signal level was approximately 6 db higher than predicted, while evaluation of the station's transmitter power showed the proper level; an investigation of this problem was initiated.

The spacecraft continued in the cruise mode, with the only significant occurrence being the transmission of the antenna hinge angle update command (RTC-2) by DSIF-41 at 2230.

The midcourse maneuver sequence was transmitted to the spacecraft during the DSIF-12 second pass. The timed RTC-4 procedure was used. This system provides a significant increase in the potential accuracy of the midcourse maneuver. The Initiate Midcourse Maneuver Command (RTC-4) was transmitted by DSIF-12 at 1203 on March 23. The spacecraft responded with a series of events and performed the expected maneuver. Post-maneuver analysis indicated that the maneuver actually performed was the maneuver intended. The DSIF continued tracking *Ranger IX* in the cruise mode following midcourse until the Goldstone third pass.

3. Midcourse Maneuver to Impact

The DSIF-12 station acquired the spacecraft at 085149 on March 24 and preparations were made both at the SFOF and Goldstone to transmit the terminal maneuver commands. *Ranger IX* was the first *Ranger* mission where a terminal maneuver was actually performed.

The stored commands, SC-4, -5, and -6, containing the magnitudes of the desired maneuver were transmitted to the spacecraft. The RTC-6 terminal maneuver execute command was transmitted by DSIF-12 at 130234. The timing of this command to within the nearest second was necessitated by the precisions desired in the turn-on of the television subsystem aboard the spacecraft. RTC-5, the television backup timer inhibit command, was transmitted at 1317. This enabled the TV subsystem to be turned on by the timer set by the transmission of RTC-6; otherwise, the RCA television timer would have turned on the subsystem prior to the desired time.

The television subsystem turned on both channels at the nominal time and DSIF-11 and -12 began receiving excellent photographs of the lunar surface. Figures 47 and

48 show lunar photographs relayed by *Ranger IX*. However, at the approximate impact -10 min, the DSIF-12 transmitter failed for an unknown reason. This in no way affected the reception of television pictures, but it did cause a momentary loss in downlink lock from the spacecraft on the telemetry channels. The transmitter was operational 2 min after the failure, but the decision was made not to turn it back on again. As a result, the last 10 min of the flight data were received in one-way lock. Shortly before impact, the spacecraft rose over the DSIF-41 horizon and that station successfully recorded video tape of the final sequence of flight. Figure 49 shows a sample lunar photograph processed from the *Ranger IX* video signal received at DSIF-41. This photograph is the same frame as shown in Fig. 48 and received at the DSIF-11, Pioneer station. The Fig. 49 photograph shows exceptional quality considering the back-up recording equipment used at DSIF-41.

4. Station Tracking Operations

DSIF tracking periods, together with nominal view periods, are presented in Table 18. Ground commands sent to the spacecraft by the DSIF are shown in Table 19. A detailed account of *Ranger IX* tracking operations at each station is provided in the following paragraphs.

a. DSIF-71, spacecraft monitoring station. The station acquired the spacecraft in two-way lock at L - 42 min (2015). The RWV modulation was on at this time and the spacecraft signal level was approximately -90 dbm. At L - 20 min, the station ground transmitter VCO was offset from 29.668180 Mc to 29.668680 Mc for the doppler offset. The ground receiver loop-noise bandwidth was 150 cps and the AGC time constant was 0.3 sec.

At liftoff the received signal level at the station was -75 dbm. The antenna operator lost visual line of sight of the spacecraft at L + 30 sec. The receiver was in good two-way lock until 214447. The *Ranger IX* transponder telemetered AGC indicated a signal level of -90 dbm at liftoff. At L + 4 min the ground transmitter power was increased by 30 db. Telemetry conditions were very good during the entire launch phase.

b. DSIF-51, Johannesburg. Launch and first passes, March 21-22, 1965. The station countdown for the *Ranger IX* mission began at 0900 and all systems were operational until 1145 when the tape recorder B wideband FM demodulator power supply developed a fault. The unit was patched to a spare power supply, curing the fault, and the countdown proceeded until at 1700 occasional random transients were noted on the receiver dynamic phase error.

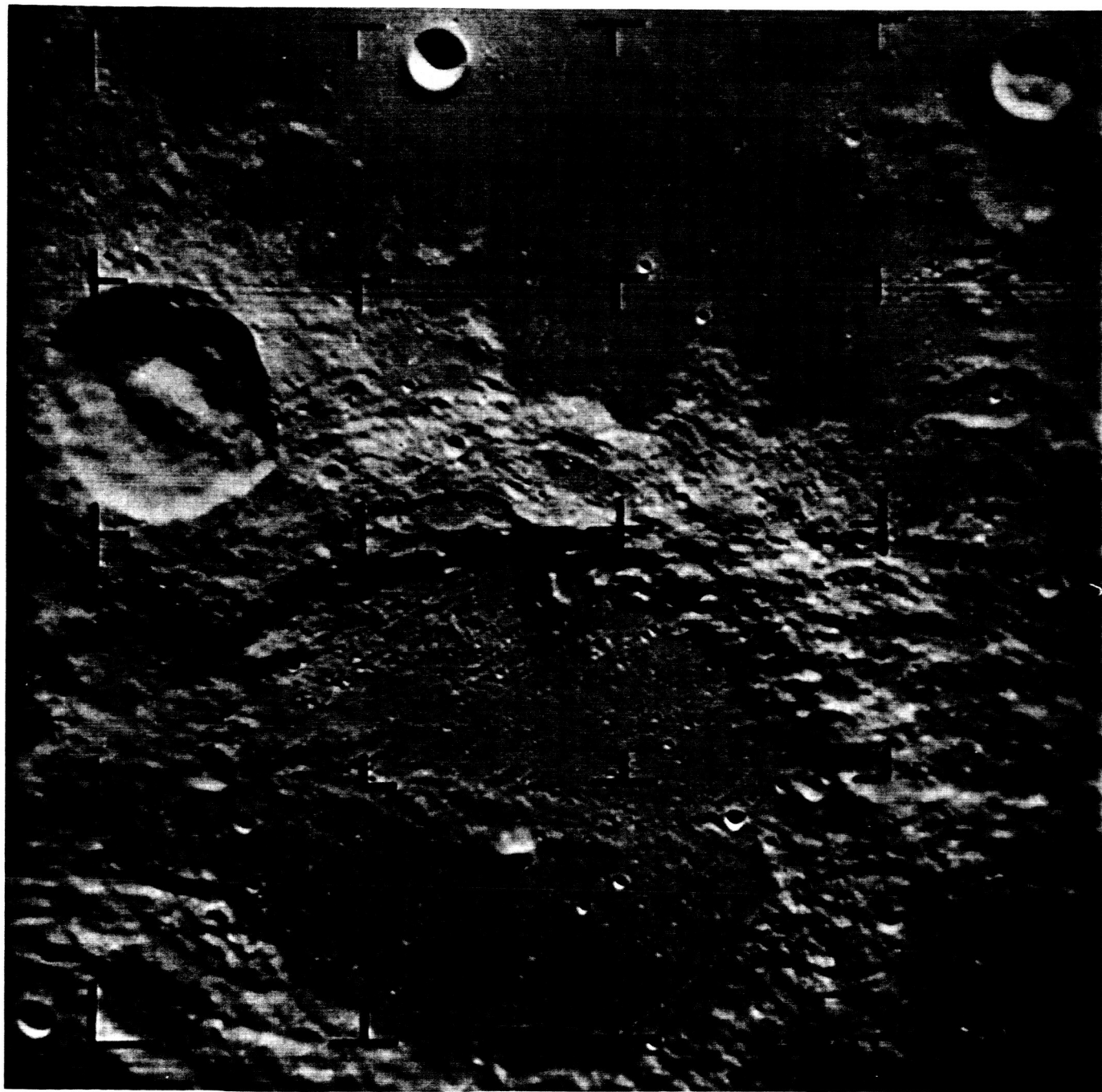


Fig. 47. *Ranger IX* lunar photograph of impact area

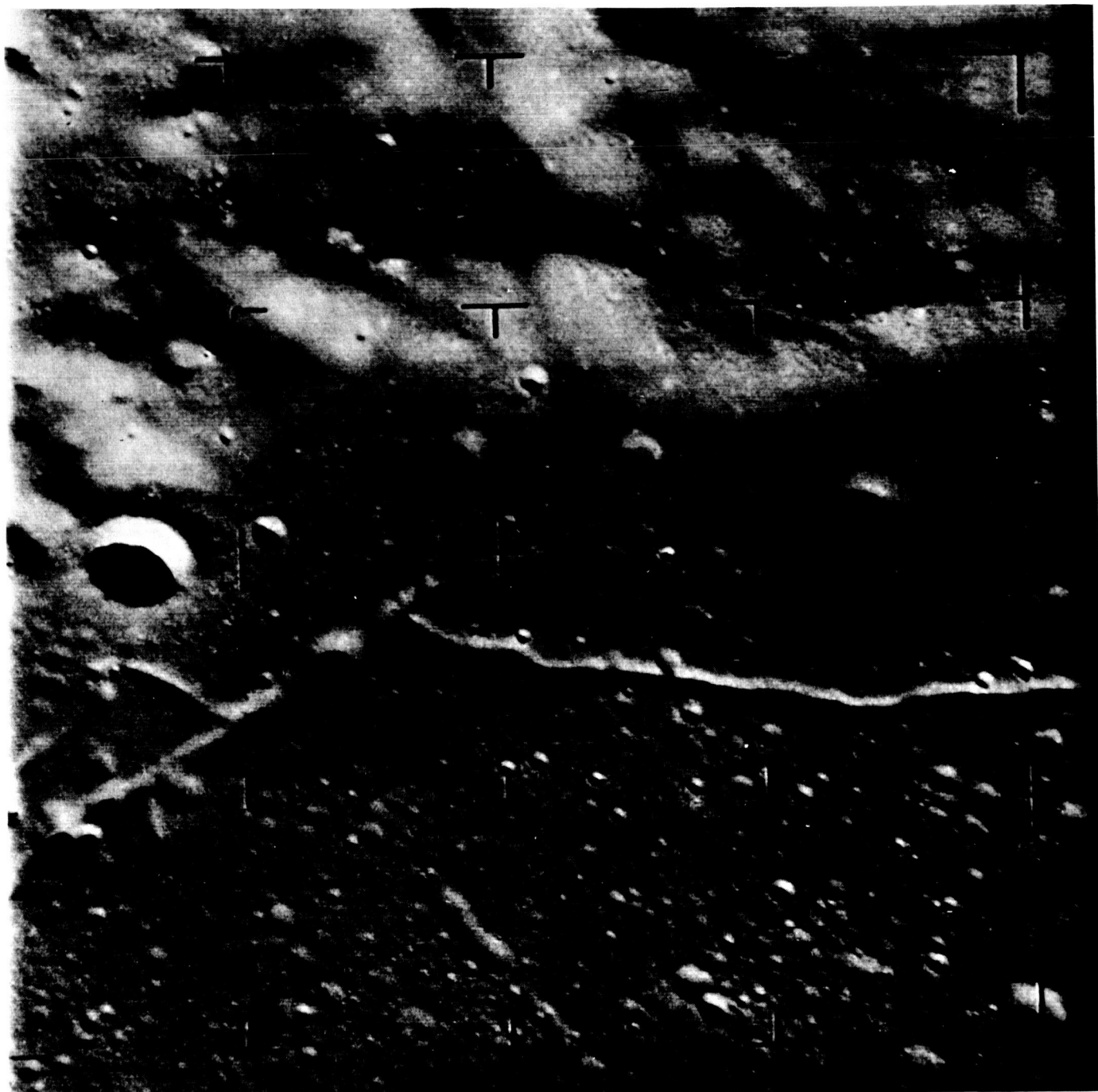


Fig. 48. *Ranger IX* lunar photograph of impact area received at DSIF-11, Pioneer station

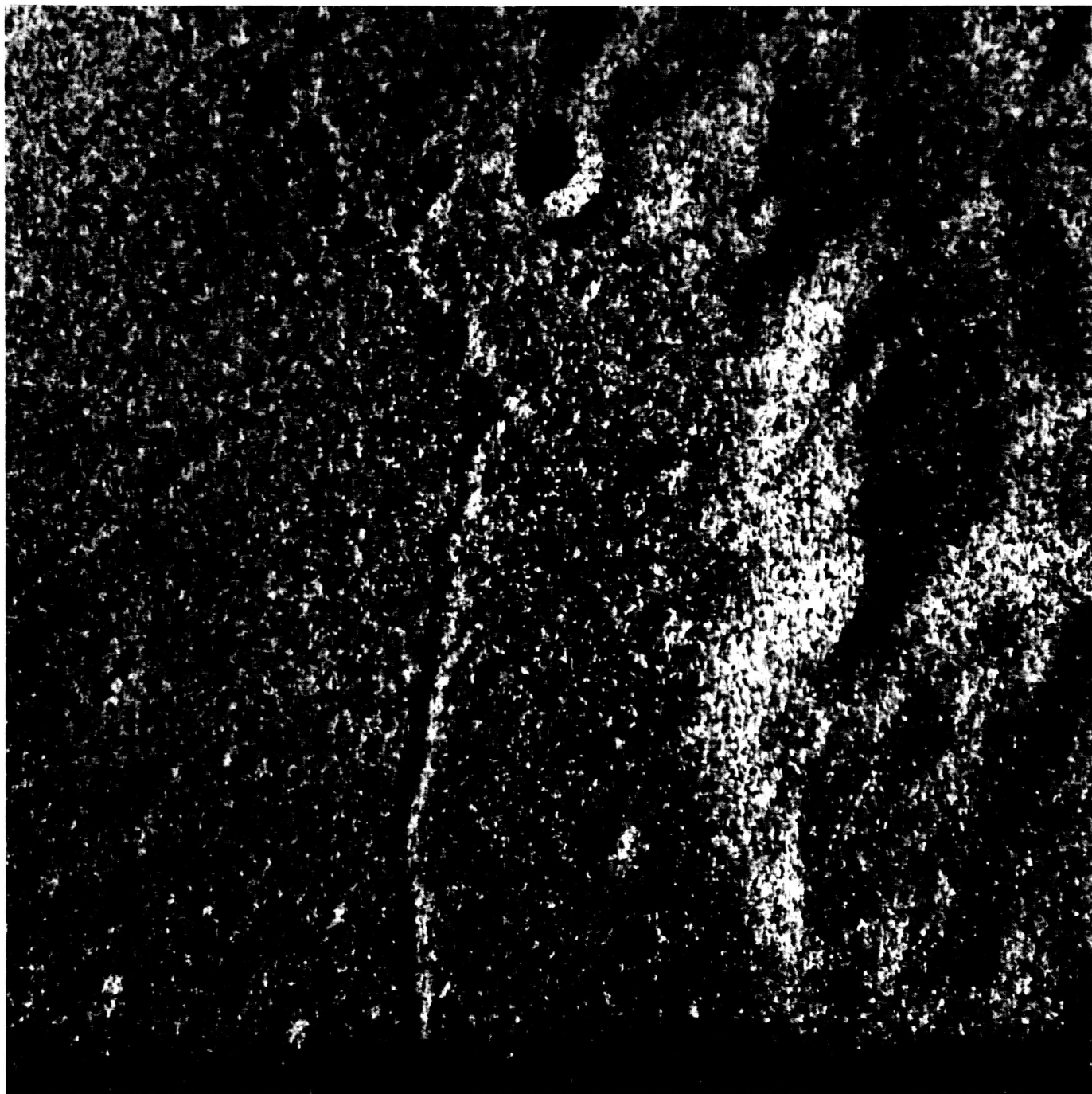


Fig. 49. DSIF-41 lunar photograph processed from *Ranger IX* video data
received at DSIF-41

Table 18. Nominal^a view periods and actual^b DSIF tracking periods for *Ranger IX*

Date	DSIF station	Pass no.	Nominal rise (GMT)	Nominal set (GMT)	Nominal view period	Acquisition by station	Loss of signal by station	Actual view period
March 21, 1965	71	Launch	Launch	L + 7.5 M	07M30S	213702 (Launch)	214447	07M35S
	51	1	220042	090100"	11H00M	220100	090500"	11H04M
	41	1	No view within 4° of main beam		00H00M	230000	014200"	2H42M
March 22, 1965	12	1	083300	171400	08H41M	082400	171700	08H54M
	41	2	142200	022200"	12H00M	133500	032200"	13H53M
	51	2	214000	094500"	12H05M	213700	100400"	12H27M
March 23, 1965	12	2	085600	174300	08H47M	085700	174400	08H47M
	41	3	143600	023700"	12H01M	140800 ^d	032000"	13H12M
	51	3	215500	095500"	12H00M	214500	101600"	12H31M
March 24, 1965	12	3	090000	140821"	05H08M	091300 ^d	140821 ^e	04H58M
	41	4	No view within 8° of main beam	140821"	00H00M	134300	135800	00H15M

^aA nominal view period is calculated to include such land masks and antenna limits as will ensure that the spacecraft remains in the main beam, i.e., within 0.5 deg or approximately 3 db of the center of the main beam.
^bPeriod between first solid receiver lock and last drop of solid receiver lock; momentary drops are neglected.
^cSet occurs on day following rise.
^dWith squint looking feed.
^eImpact.

These transients were not considered serious enough to jeopardize station participation in the mission.

Liftoff occurred at 213702 and at 215533, 5 min prior to the anticipated spacecraft rise, the station transmitter was switched on at low-power. At 220100 the receiver acquired a strong signal in two-way lock as the spacecraft cleared the horizon and servo went to autotrack at 220135. Three min following acquisition, the station transmitter power was increased to 200 w. Following an Xa frequency change at 2211, the transmitter was locked to the synthesizer at 221444. Event blips corresponding to solar panel extension and Sun acquisition were observed between 2237 and 2240. The signal strength had reached an average level of -108 dbm by 2250.

Transient spikes on the transmitter output apparently caused receiver loss of lock at 232218 and again at 234715. The station reduced transmitter power at 000215 and turned off at 000505 when transfer to DSIF-41 was successfully executed. During the period following transmitter turnoff an attempt to cure noisy doppler was made by changing the rubidium standards and the transmitter was tested on a dummy load. Momentary receiver out-of-lock conditions occurred between 0010 and 0023 and the spacecraft was taken over again from station DSIF-41. DSIF-51 turned on the transmitter again at 002520. A B-2-1 event blip indicating Earth acquisition was the only

noteworthy event until the receiver dropped lock momentarily at 041620. This loss of lock was reported at 050334, 063614, 072232, and 082646.

Transfer to DSIF-11 was initiated with the transmission of 10 cps modulation at 084000 and the transmitter was turned off at 084522. Tracking continued in the GM 32 mode with the receiver out of lock for 2-3 sec at 084600 as the receiver switched to C-3 and again at 084616, 085353, and 085558 for reasons not established. Servo reached pre-limits at 085912 and the receiver again dropped lock for 5 sec at 090257. At 091450 the received signal had been degraded by the horizon mask sufficiently for all discriminators to loose lock. The decommutators went out of sync at 091715 and the receiver dropped lock at 092518.

Pass 2, March 23-24, 1965. Due to the exceptional accuracy of the lunar transfer orbit, no midcourse maneuver had been performed when DSIF-51 reacquired the *Ranger IX* at 213620 following a countdown which started at 1200. During the station countdown, the transmitter tripped out at 1952 and a blown fuse was found in the arc detector. The receiver also continued to experience random transients on the dynamic phase error during this period. Aside from these incidents the countdown proceeded without incident.

Table 19. Ground commands from DSIF to Ranger IX

Command	Initiated (Date/GMT)	Verified (GMT)	DSIF station	TM event blips recorded at station
RTC-0	81/092600	092638	12	N/A
RTC-0	81/092800	092838	12	N/A
RTC-3	81/093000	093038	12	B-20
RTC-0	81/222600	222638	41	N/A
RTC-0	81/222800	222838	41	N/A
RTC-2	81/223000	223038	41	B-20
RTC-0	82/105000	105038	12	N/A
RTC-0	82/105200	105238	12	N/A
SC-1	82/105400	105438	12	B-20
SC-2	82/105600	105638	12	B-20
SC-3	82/105800	105838	12	B-20
RTC-0	82/113100	113138	12	N/A
RTC-0	82/113300	113338	12	N/A
RTC-3	82/113500	113538	12	B-20
RTC-4	82/120300	120338	12	B-20
RTC-0	82/132600	132638	12	N/A
RTC-0	82/132800	132838	12	N/A
RTC-3	82/133000	133038	12	B-20
RTC-0	83/115400	115438	12	N/A
RTC-0	83/115600	115638	12	N/A
SC-4	83/115800	115838	12	B-20
SC-5	83/120000	120038	12	B-20
SC-6	83/120200	120238	12	B-20
RTC-6	83/130234	130312	12	B-20
RTC-5	83/131700	131738	12	B-20
Real time commands		Stored commands		
RTC-0 = Clear command		SC-1 = Midcourse maneuver roll duration		
RTC-3 = Antenna switchover		SC-2 = Midcourse maneuver pitch duration		
RTC-4 = Begin midcourse maneuver		SC-3 = Midcourse maneuver velocity increment		
RTC-6 = Initiate terminal maneuver		SC-4 = Terminal maneuver first pitch duration		
RTC-8 = Maneuver override		SC-5 = Terminal maneuver yaw duration		
		SC-6 = Terminal maneuver second pitch duration		

A B-20 blip was noted at 223040 corresponding to DSIF-41 transmission of RTC-2, and the momentary receiver out-of-lock condition recurred at 012415, just prior to transferring the spacecraft to DSIF-51 at 013000. A station transmitter was switched on at this time. Seven momentary receiver dropouts were recorded between 023300 and 030919.

Preparations for transfer to DSIF-11 began at 090700 with the transmitter reducing power and turnoff occurring at 091019. Tracking continued until the receiver reached limits at 094243 and lost lock as the spacecraft went below the horizon at 100440.

Pass 3, March 23-24, 1965. The countdown for this pass began at 1400 and proceeded smoothly until completion at 1956. Two minor incidents occurred, but these were not serious enough to jeopardize the station readiness for the mission. A data \times 30 multiplier failed to re-lock on the low frequency side and necessitated replacement of a noisy power supply and card along with some realignment. A B-20 discriminator also failed and was replaced.

The *Ranger IX* spacecraft was initially acquired by the DSIF-51 at 214325, but the receiver noticed an anomalous signal and dropped lock at 220350 to reacquire at 220425. The discriminators were unable to lock on the signal, so the receiver was again taken out of lock at 220453. After rephasing the wideband phase detector, the receiver achieved a firm lock at 220703. At 2218, the CEC recording gear box developed a fault which made it necessary to run the paper at 0.4 ips instead of 0.2 ips.

Transfer from station DSIF-14 was successfully achieved at 230000 when DSIF-51 turned on the transmitter. Momentary receiver drop-outs were observed at frequent intervals for the remainder of the pass. At 000100 *Ranger IX* was transferred back to DSIF-41 to be taken over again by DSIF-51 at 020000. At 091031, a subsequent transfer to station DSIF-11 occurred, and by 095250 Servo was in limits. The receiver lost lock at 102145 as *Ranger IX* passed over the western horizon for the last time, some 4 $\frac{1}{2}$ hr before the spacecraft took the third consecutive successful series of photographs of the lunar surface.

c. DSIF-41, Woomera. Pass 1, March 21-22, 1965. The receiver was in lock with the spacecraft signal at 225212 in the acquisition aid mode. This antenna configuration was used throughout Pass 1. All telemetry rates were reported in sync at 230700. The signal level at 230900 was -142 dbm rising to -138 dbm at 234235 and again dropping to -143 dbm at 235530. At 235846 the receiver was reported out of lock for 5 sec.

A non-standard transfer of two-way lock was successfully accomplished from DSIF-51 at 000400 with the DSIF-41 transmitter on at 200 w and 29.668628 Mc. At 000502, the DSIF-41 receiver was reported out of lock for about 40 sec. The signal level at 000650 was -122 dbm with the receiver going to good data at 000710. During the period between 001021 and 002318 the receiver went out of lock on several occasions for durations up to 33 sec.

At 002200, the signal level was reported at -145 dbm and unsteady. The low signal level to and from the spacecraft during this period caused considerable difficulty in maintaining lock at DSIF-41 and -51. At 002400, DSIF-41 reported three good lock periods followed by two out-of-lock periods of 5 and 13 sec at 002421 and 002443. The station went to one-way lock and reported good doppler data following a transfer to DSIF-51 at 002500. At 003500, the signal level was reported at -146 dbm, diminishing gradually after that period until at 012100 when the level was -156 dbm. The DSIF-41 receiver went out of lock at 014457 marking the end of Pass 1.

Pass 2, March 22-23, 1965. The station acquired the *Ranger IX* signal (-140 dbm) on the acquisition aid antenna at 133448, March 22, 1965. The signal was transferred to the main beam some 37 min later at 141144 at a level of -125 dbm. The CEC recorder was stopped at 141410 for an operator adjustment and restarted again at 141435. At 141610, servo went from aided to auto tracking and the signal level was up to -112 dbm some 2 min later. The DSIF-41 transmitter was turned on to the 200 w level preparing for the transfer of two-way lock to DSIF-12 which was completed at 142700. Two subsequent transfers of two-way lock between DSIF-12 and -41 were accomplished during pass 2. The final transfer to DSIF-41 was completed at 163125.

Beginning at 221145, DSIF-41 turned on command modulation and sent and verified two RTC-0 and one RTC-2 commands immediately prior to this command transmission. At 213620, DSIF-51 had acquired the spacecraft signal in three-way lock. DSIF-41 turned off command modulation at 223425 with the spacecraft signal level reported at -115.6 dbm. At 000020, receiver doppler data went to a bad condition and the transmitter X_a frequency was changed to 29.668362 Mc some 3 min later. The doppler went to the good condition at 000450. A transfer of two-way lock was accomplished at DSIF-51 at 012744 with two bursts of 10 cps modulation noted 3 min later. Doppler went to bad at this time and the transmitter was turned off at 013028. Doppler became good again at 013110 and the station tracked in cruise mode for the remainder of Pass 2. Some minor problem with the recording facilities at DSIF-41 were noted during this pass, but no failures of a significant nature occurred.

Pass 3, March 23-24, 1965. The station began recording the spacecraft signal at 132900. Until 134800, the receiver was reported in and out of lock with the offset dipole in use. At 134837 Servo went to aided track and the receiver was again reported in and out of lock for a 2 min period. At 141000, the signal was at the -134 dbm level. The receiver went to the main beam at 143941 with the *Ranger IX* signal level at -118 dbm. The transmitter X_a frequency was at 29.66268 Mc at 145200 and the station started three bursts 10 cps modulation 3 min later in preparation for transfer of two-way lock from DSIF-12.

At 145615 the receiver was out of lock for 6 sec due to a sideband lock condition. The signal level 1 min later was up to -117 dbm and the doppler was found to be 3 cps higher than predicted. The DSIF-41 transmitter was turned on at 200 w at 150000 and the transfer from DSIF-12 was completed at 150908. The return of two-way

lock at DSIF-12 was accomplished at 165600 and returned to DSIF-41 again at 170001.

At 180844, a glitch was noted on all telemetry channels. One min later the receiver went out of lock, Servo went to break, and the 30.455 Mc VCO was replaced. The receiver was back in lock again at 181320 with two-way lock reported at 181704. Two-way lock was transferred between DSIF-12 and -41 three more times during this pass. Tracking continued without incident until 033935 on March 24, 1965 when DSIF-41 lost the signal over the local horizon.

Pass 4, March 24, 1965. At 133746, the station obtained three-way lock with a signal strength of -141 dbm. The signal strength increased until at 134300 it was -135 dbm. It then decreased to -138 dbm, at 134815, when the antenna was swept in a zigzag fashion to optimize the signal strength. At 134953, the sweep was terminated with a signal strength of -134.5 dbm. The antenna was then moved at an approximately sidereal rate; however, by 135416 the signal level had fallen to -142 dbm, and the antenna was 0.45 deg behind nominal; the offset being assumed as the same as that measured at 1350. This displacement was not realized at the time, and so a wide search in both axes was made.

The hour angle peak was reached 0.5 deg ahead of the 1350 offset; it seems that the earlier peak was not correct as then the large drop in level ending at 1354 would be due to a 0.95 deg offset which is more reasonable. Unfortunately, the antenna was not returned to the peak, but was left 0.8 deg ahead, probably because of a time variation of the signal level at that time. The signal level, however, was only about 2.5 db down on the peak (this agrees with the antenna polar diagram). At 135604, the antenna was maintained successfully at sidereal rate for about 5 min, and the appearance of video noted on the spectrum analyzer at about 1349.

The receiver lost lock at 135808. This is now known to have been caused by the loss of up-link by DSIF-12, but at the time this was not realized due to the slow communications between the SFOF and DSIF-41. Under other circumstances, such a loss of lock may have been deduced, but it was not recognized as a possibility during the picture-taking phase of such a successful mission. The receiver operator first attributed the loss of lock to some ground receiver problem, and searched in the neighborhood of the previously heard frequency. It was noted that the video signals were still clearly visible on the spectrum analyzer. At 140020, it was decided to conduct

an hour-angle scan, this was made between 274.77 and 272.16. At 140035, the receiver regained lock and the signal was peaked; however, the signal strength was -146 dbm and contained no telemetry. This was later found to be a coherent RF signal from the L- to S-microwave system. At 140821, the video signals disappeared and the blue net reported impact; the receiver continued in lock, however, with the same doppler frequency and characteristics.

d. DSIF-12, Echo, Goldstone. Launch pass, March 21, 1965. The countdown for the launch pass proceeded normally and the station was mission ready at 1915. Figure 50 shows an external view of the DSIF-12 station. Following liftoff at 213703, DSIF-51 acquired two-way lock with the *Ranger IX* at 220150. After confirmation of lunar injection, DSIF-12 placed the station in standby status at 221257 until the beginning of the countdown for the first pass.

Pass 1, March 21-22, 1965. The countdown for this pass was normal and the station was ready for acquisition at 0520. One-way acquisition occurred at 082410, and two-way lock was confirmed at 084533. Equidistant measurements for DSIF-51 and DSIF-12 were made at 085500 with a ground signal level of -122 dbm and an AGC voltage of -0.483 . Equidistant measurements for DSIF-41 and DSIF-12 were made at 145800 with a ground signal level of -110.6 dbm, and an AGC voltage of -1.21 . Equidistant measurements with DSIF-41 and DSIF-12 were also taken at 161500 with a ground signal level of -112 dbm and an AGC voltage of -1.141 . Tracking conditions were good throughout Pass 1.

The midcourse maneuver, normally performed during the DSIF-12 first pass, was rescheduled for the second pass because of the initial accuracy of the lunar injection. During the first pass, the antenna changeover command was the only command initiated by DSIF-12. Signal level began decreasing at 093047, dropping to -131 dbm, and increasing to a steady -109.8 dbm at 093210. A transfer between DSIF-12 and -41 was made at 142501, and back to DSIF-12 at 152528. The final transfer was made to DSIF-41 at 163027, and the first pass ended at 171738. No difficulty was experienced during this pass. The SFOF reported a 7 db higher transmitter signal level for DSIF-12, which was investigated, with no anomaly noted in the transmitter. Telemetry conditions during the first pass were good with no equipment difficulties noted and with all systems operating normally.

Pass 2, March 22-23, 1965. Station countdown proceeded normally and the system was ready for the second

pass acquisition at 073000. A defective forward escapement coil and reperforator were replaced in the backup RWV at 045500 and the unit tested for full operation. There were no other equipment defects noted. One-way acquisition occurred at 084600 and two-way lock was confirmed at 091035. An equidistant measurement was made at 092500 with a ground level signal of -116.49 db and an AGC voltage of -0.86 . Three transfers were accomplished during the latter part of the second pass; the first at 150010 to DSIF-41, the second at 160002 back to DSIF-12, and the final transfer at 170120 to DSIF-41. Again, the 7 db higher transmitter signal level was reported by the SFOF, and a second investigation revealed no differences in the transmitter operating levels.

The midcourse maneuver sequence was performed by DSIF-12 during the second pass. Telemetry conditions were good for the entire pass and Channel 8 telemetry was off from 122258 to 123341 as programmed. All sub-systems operated normally.

Pass 3, March 23-24, 1965. The station countdown for this pass proceeded normally and at 064600 the system was ready for acquisition. One-way acquisition occurred at 085059 and two-way lock was confirmed at 091022. Tracking conditions were good from acquisition until 135818, 10:03 min from impact at 140821, when the receiver lost lock due to a transmitter turn-off. The receiver was in one-way lock at 135914 for a total out-of-lock of 56 sec. There was no loss of video during this period. One equidistant measurement was made between DSIF-12/-41 at 095448 with a ground signal level of -119.2 dbm and an AGC voltage of -0.713 . The receiver changed to 60 cps bandwidth at 090138 for two-way acquisition and to 20 cps at 091111 for the duration of the third pass.

The terminal maneuver sequence began at 115400. Start of television warmup was reported by RCA at 134835 and full video on both channels appeared at 134934. The ground signal level at TV turn-on was -119.2 dbm. The impact counter, uncorrected, indicated impact occurred at 140821.327997. Except for loss of telemetry during the 56 sec of receiver out of lock when the transmitter failed, telemetry conditions were good throughout the third pass. The transmitter turned off at 135818. At 140055, the 2-min time delay was ready for reapplication of transmitter power. The transmitter was not used for the duration of the time to impact. The cause of the outage was immediately apparent, as the 2-min time delay indicated power could be restored at the end of the proper delay interval. The up-link was not re-established because of the short time remaining until impact.



Fig. 50. DSIF-12, Echo station, Goldstone

Investigation of the outage was delayed until completion of the mission. During the course of the investigation, an unsoldered wire was discovered attached to the plate terminal lug of CR-6 (TB-802904) by a single loop. This wire was connected at the other end to the cathode side of CR-8 on the same board, a part of the UD10/7 high-voltage power supply cabinet. With the klystron beam voltage on, movement of the loose connection caused the exact outage indication to be duplicated. When the wire loop was soldered, the outage duplication could not be repeated, thus clearing the cause of the original outage.

H. Ranger VIII Tracking Performance Evaluation

In general, the performance of the DSIF stations, during the mission, was excellent. The maintenance of two-way lock to the horizon by DSIF-71 and the early acquisition of the spacecraft by DSIF-51 added considerably to the coverage of the mission. There were, however, the following problem areas.

1. During midcourse, DSIF-12 experienced drop of lock during roll and pitch maneuvers. During the maneuvers, the signal level fell drastically and appeared erratic. When this condition occurred, the DSIF-12 receiver dropped lock. Throughout the midcourse the receiver operator made only minor tuning adjustments to follow the predictions in an attempt to reacquire. During the midcourse period, the records show that the maximum adjustment made of the VCO frequency was 7 cps (or $X30 = 210$ cps at 960 Mc).

Each time the spacecraft signal became strong enough for DSIF-12 to acquire, the receiver was relocked, significantly always on the carrier and not on a sideband. When the spacecraft signal surged back as burnout occurred, the carrier, as well as the telemetry channels, went into lock. Plots of the doppler residuals during the midcourse substantially support the above.

From all indications, the spacecraft signal was drastically reduced during the midcourse maneuver and came back up to normal during the burn period.

2. During the mission, signal level shifts and discrepancies from nominal predictions in downlink occurred. The degree of variance between the ground-received signal level and predictions were roughly as indicated:

	1st Pass	2nd Pass	3rd Pass
Johannesburg DSIF-51	3 db high at end of pass	4 to 6 db high	4 to 6 db high

Echo DSIF-12	3 db high at start. 2 db high towards end	1 db high	4 db high
Woomera DSIF-41	2 to 3 db high	1 to 2 db high	1 to 2 db high

The Echo and Johannesburg stations experienced shifts during the third pass. Echo shifted from -117 to -112 dbm, while Pioneer, which was viewing simultaneously, did not experience this shift. Johannesburg experienced two dropouts. An uplink shift occurred at the Echo station during cruise after midcourse.

Momentary dropouts were recorded at Johannesburg and Woomera, the L- to S-band stations, immediately after changeover (two-way to three-way mode). There were no dropout problems with the L-band stations (Goldstone Pioneer and Echo).

Net control procedures were very smooth. During a transfer from DSIF-41 to DSIF-51, there appeared to be a problem of false lock or sideband lock. Station 51 was instructed to turn off its transmitter and reacquire.

Investigations are continuing in spacecraft performance to try to elucidate these occurrences.

Angle data from DSIF-41 and DSIF-51 were not as good during *Ranger VIII* as they were for *Ranger VII* because there was no time to recalibrate after the S- to L-band conversion.

The quality of the ground telemetry data was excellent. All stations accomplished decommutator synchronization very rapidly and sync was maintained throughout the mission. Even during the midcourse RF dropout, DSIF-12 maintained sync. Some data were lost due to line outage and realtime data updating.

I. Ranger IX Tracking Performance Evaluation

There were no failures or problems which jeopardized the *Ranger IX* mission, and no operational difficulties were noted during the mission. The following is a station summary of the problem areas encountered during the *Ranger IX* mission.

1. DSIF-51, Johannesburg

At prelaunch, the receiver was reported showing transients on the dynamic phase error. These transients

reportedly appeared occasionally but were not of such magnitude as to cause the receiver to drop lock.

During the first pass, the jitter on the doppler was on the order of 15 to 20 deg, occurring randomly, often at intervals of 30 min or more and lasting about 2 or 3 min. The receiver did not drop lock.

The DSIF-51 receiver anomalies remained a chronic condition in all passes during the mission. Drop of lock began to occur and became increasingly frequent as the mission progressed, particularly during the third pass.

The initial portion of the DSIF-51 first pass was marked by noisy doppler data. The data were on the order of 4 to 5 times more noisy than nominally acceptable. The cause seems to be fairly well established at this date as being due to intermittent noise on the rubidium standard, possibly caused by an overload. When the VCO, the standby rubidium standard, or the synthesizer was used, the doppler data were not marred by excessive noise.

The spacecraft AGC indicated that the DSIF-51 uplink power level was on the average 3.5 db in excess of the nominal predictions during the first pass. This was after solar acquisition and when the spacecraft was no longer tumbling. Periodically during the first pass, the uplink power level at the spacecraft was 4 to 5 db above nominal predictions. During the remaining passes, DSIF-51 exceeded nominals on the order of 1.5 to 2.0 db.

In general the received signal level at DSIF-51 during the mission was high relative to nominal predictions, being on the order of +2 to +3.5 db.

2. DSIF 12, Echo

Similar to DSIF-51, the Echo station uplink power to the spacecraft exceeded predicted nominals, particularly so during the first pass when levels of +5 to slightly higher than +6 db above nominal were detected by the AGC of the spacecraft.

Ten min before impact, the Echo transmitter turned off. The main power was off, the beam voltage ready indicator was out, and the 2-min time-delay light was on. A check of the klystron filament undercurrent interlock circuitry was made and an unsoldered wire was discovered.

When the transmitter kicked off, a drop lock occurred. However, the downlink was quickly re-established. No video data were lost. When the two-way link was lost with

the transmitter turn-off, no attempt was made to re-obtain two-way so as not to impair video reception in any manner.

3. DSIF 41, Woomera

Woomera experienced receiver VCO difficulties on two occasions. On the first occasion, the receiver was out of lock for approximately 4 min while the VCO module was changed. In the case of the second failure, the receiver was intermittently out of lock over a 4-hr period due to this faulty 30.455 Mc VCO. Changing the VCO module cured the situation.

4. Excessive Uplink Power Levels

Concerning the excessive uplink power levels, the following is to be noted relative to the situation:

Between passes during the mission, DSIF-12 was instructed to recalibrate their output power level. These checks indicated that the station was putting out 200 w (as specified). Further calibration checks after the mission substantiated that calibrations made during the mission were correct.

DSIF-51 and DSIF-41 were also instructed during *Ranger IX* to recalibrate their power output. The DSIF-51 measurement indicated that they were at the 200 w output level. In addition to the standard calibration check, DSIF-41 conducted a calorimeter test which indicated the output power level was actually 148 w.

The spacecraft AGC indicated that the DSIF-41 uplink level was in fairly close agreement with the nominal predicts, running on the average of about 0.5 db to 1.0 db higher than nominal.

In view of the foregoing picture, the predicted values are subject to conjecture.

Taking everything into consideration, the DSIF performance during the *Ranger IX* mission was more than satisfactory. The system noise temperature and receiver threshold calibrations of all stations in the Net for the entire mission were very good as observed in Table 20.

J. Participation of Non-DSIF Agencies

1. Space Flight Operations Facility (SFOF)

The SFOF is located at JPL, Pasadena, California. The SFOF utilizes operations control consoles, status and operations displays, computers, and data processing equipment

Table 20. *Ranger IX* DSIF station calibration figure

Station	Pass	Calibration system noise temperature °K		Specification system noise temperature °K	Calibration receiver threshold (dbm)		Specification receiver threshold (dbm)
		Pre-track	Post-track		Pre-track	Post-track	
12	1	117	115	110 ± 30	-166	-165	-165 ± 1.5
	2	113	117		-165	-164	
	3	108	110		-166	-166	
41	1	220	230	$240 \begin{smallmatrix} +25 \\ -65 \end{smallmatrix}$	-162.5	-163.5	-162 ± 1.5
	2	225	230		-162.5	-162.5	
	3	225	220		-162.5	-162.5	
51	1	190	185	$240 \begin{smallmatrix} +25 \\ -65 \end{smallmatrix}$	-161	-161	-162 ± 1.5
	2	190	185		-161	-161.5	
	3	190	185		-162	-162	

as tools in the analysis of spacecraft performance and space science experiments, and communication facilities to control space flight operations.

a. Facility. The SFOF included a display system, a gallery for observers, television output of certain cameras with an audio status line for an internal/external laboratory information system, access control and facility security, standby maintenance personnel support, standby room for operations personnel, bunkroom, technical area assistance support for the Spacecraft Data Analysis Team (SDAT), and the Flight Analysis and Command (FPAC) group, and the necessary capability for the correction of any facility housekeeping failures or problems.

One facility failure occurred 2 hr before the *Ranger VIII* launch. This was the failure of the No. 2 diesel generator which took 1½ hr to repair. Several minor display equipment failures occurred and were fixed in near-real time during the *Ranger VIII* mission.

Between the *Ranger VIII* and *IX* missions, the SFOF, in an effort to improve their electrical systems reliability, performed a complete facility checkout. The checkout was accomplished on March 8, 9, and 10 during the Johannesburg *Mariner IV* view period, at which time the station was converting from the S- to L-band configuration. The system had not been thoroughly checked out previously because of the heavy operation schedule. Numerous small problems experienced in the past, some of which could cause considerable trouble during the critical periods of a mission, motivated this action.

The performance of the SFOF in support of the *Ranger IX* mission was quite effective, with all requirements being

met. *Ranger IX* was the first use of the Television Ground Data Handling System for display of real-time spacecraft television in the SFOF and for public dissemination.

The SFOF provided a secure area for the analysis of the lunar television pictures by the Space Science Analysis and Command (SSAC) group and experimenters for two weeks after the conclusion of the flights.

b. Central computing complex. This complex consisted of two IBM 7094 computers, three IBM 1401 computers, an SC-4020 plotter, a PDP-1 computer, the Telemetry Processing Station, and the personnel required to operate and maintain the equipment.

During the days prior to the *Ranger VIII* and *IX* launches, the complex executed a launch-checkout sequence of events which included testing and shakedown of both software and hardware. The completion of this checkout indicated a state of mission readiness for the complex.

In general, all computer programs performed well during the missions. The orbit determination and trajectory computation effort was very satisfactory and all scheduled tasks were completed. The computation of the midcourse and terminal maneuver commands proved to be excellent. Real-time display of raw and converted engineering telemetry data, including television subsystem data, was supplied to the Spacecraft Performance Analysis Area by the PDP-1 computer and the Telemetry Processing Station. Bulk processing, in the form of printed listings and plots, of engineering telemetry data on the IBM 7094's was satisfactory, although more computer time was consumed than had been anticipated.

The computers and associated equipment had a good record of reliability during the course of the mission. The few equipment problems which occurred were minor and caused little or no delay to the operations due to quick repair and/or duplicate or backup hardware capabilities which were available.

Post-flight processing of tracking and telemetry data began immediately after completion of the missions.

c. Communications center. The performance of the communications center during the flights was quite effective. The communications failures experienced within the SFOF were due to terminating apparatus only, and were of a type and quantity well within normal expectations. Mechanical failures of teletype equipment, tube and semi-conductor failures, plus minor technical adjustment problems constituted all of these failures.

2. Ground Communications System (GCS)

The DSN Ground Communications System consisted of: (1) voice, normal and high data rate teletype circuits provided by the NASA world-wide communications network between each overseas DSIF station and the SFOF, (2) teletype and voice circuits between the SFOF, Goldstone stations and Cape Kennedy, and (3) a microwave link between SFOF and Goldstone.

During the *Ranger VIII* mission, a major catastrophe occurred 5 hr after launch when 9 of the 14 circuits to JPL were lost. This disrupted all but the analog circuit to the Cape, and all but the voice circuit to Johannesburg. The problem, due to a dug-up coax cable in the Los Angeles area, fortunately occurred during a non-critical phase of the mission. The lost circuits apparently were in the same cable, and reflects a total lack of diversity which the common carriers were to provide.

NASCOM set up meetings with the common carriers in an effort to resolve this problem. Not only is complete diversity required both here and overseas, but it is also important to know the exact routing of these circuits.

Prior to *Ranger VII* launch the circuits were interrupted by carriers testing. This could be a serious problem, for it cuts down the time available in establishing system contact, and consequent operational status. This problem has been taken up with the carriers, and in the future circuit-testing periods will be set up so they will not interfere with pre-launch operations.

The *Ranger IX* mission was supported, in part, by circuits which were not nominal DSN GCS circuits. The substitute circuits, all to Woomera, Australia, are shown along with the nominal South African circuits in Fig. 50.

Teletype circuits to Johannesburg performed fair, with poor radio propagation comprising the major cause of circuit outage. The poor conditions were expected, as the first quarter of the year is normally adverse in radio-propagation qualities.

There were a few non-propagation failures of lengthy duration and these were primarily the result of equipment failures at the London Radio Terminal and at RCA, New York. Equipment failures and land-line carrier failures in the Pretoria, South Africa, area, although small in number, caused an appreciable loss of operational time on the teletype circuits.

The teletype circuits to Woomera, Australia, operated exceedingly well despite the fact that they were relatively new and unproven circuits. The small number of outages that did occur on these circuits were caused by equipment failures at the Honolulu and Sydney Radio Terminals. These failures were almost exclusively tape-transfer FRXD problems.

Voice and analog circuits to DSIF-41 were 100% reliable; there were no outages attributable to circuit problems during the entire Woomera view periods.

Failures of communication hardware within the SFOF were limited to vacuum tubes, fuses, semi-conductors, diodes, and mechanical maladjustments. All failures were within normal expectations and loss of circuit times was held to a minimum.

3. Air Force Eastern Test Range (AFETR) Support for *Rangers VIII* and *IX*

The AFETR was again assigned the responsibility of providing JPL with orbital elements of the parking and transfer orbits; acquisition information for the DSIF stations; and the raw data that were used by JPL to provide a back-up computation of the transfer orbit.

a. Ranger VIII C-band radar system coverage. AFETR radar tracking coverage and commitment are shown in Table 21. The radar at 91.18 (MILA) failed to track due to a defective vacuum tube in the angle tracking system. A second intermittent problem in the distribution box of the hydraulic package caused the digital data to fail, slew check during countdown.

Table 21. AFETR radar tracking coverage and commitment for Ranger VIII

Radar	Commitment sec from launch	Coverage sec from launch
1.16	16-200	10-310
19.18	18-300	12-477
0.18	26-300	14-463
3.16	86-310	56-487
7.18	240-570	208-598
91.18	405-680	None
Twin Falls	"	970-1340
12.16	"	None
13.16	"	1730-7928

*Any 60 sec of track between Agena second burn-out and retro fire, by one or more of the three stations, depending on launch day and launch azimuth.

Radar 7.18 (Grand Turk) digital data were called No-Go at L-60 min. The data were declared Go at L-23 min. Radar 12.16 (Ascension) did not acquire track due to low elevation angles associated with the trajectory of *Ranger VIII*. Terrain restrictions limit track for elevation angles below approximately 5 deg from 80 to 110 deg east of true north. After *Agena* second-burn cut off 13.16 (Pretoria) was used to provide Class I coverage.

b. Ranger VIII telemetry coverage. Table 22 shows the coverage of the *Agena* VHF telemetry versus the commitment; the *Atlas* telemetry commitment to L-307 was met. Table 23 shows the AFETR L-band coverage for

Table 22. AFETR coverage of Agena VHF telemetry for Ranger VIII

Station	VHF Commitment sec from launch	VHF Coverage sec from launch	Mark Events
1	0- 349*	0- 497	1-7
3	80- 349*	48- 515	
91	349- 669	325- 748	7, 8
Timberhitch	778-1003	708-1081	
Twin Falls	973-1278	860-1360	9
Sword Knot	1252-1710	1210-1864	9, 10, 11, 12
12	1350-1410	1190-1780	9, 10, 11, 12
13	1645-2250	1680-6580	13

*Atlas links committed to T + 307 sec.

Table 23. AFETR L-band coverage for Ranger VIII

Station 1, Tel 3	0- 497 sec
RIS Twin Falls	870-1360 sec
RIS Sword Knot	1323-1423 sec
Station 12	1224-1634 sec
Station 13	Negative

Ranger VIII. The equipment was operated on a limited commitment basis with no guarantee of data.

Failure of Station 13 (Pretoria) to acquire L-band telemetry was thoroughly investigated; however, no final results were available. Due to an internal Hangar AO (Cape Kennedy) interface problem Tel 2 (Cape Kennedy) and Station 91 (Antigua) spacecraft telemetry data were not available for use.

In general, the telemetry tapes recovered and provided by AFETR for *Ranger VIII* were satisfactory in all respects. AFETR provided continuous and excellent coverage from lift-off until L + 27 min (1732000), when Ascension lost lock. There was very little difference in the data quality recovered from the *Agena* sub-carrier (244.3 Mc) and the L-band sub-carrier (960.05 Mc), both being satisfactory. Figure 51 shows the coverage provided by the AFETR telemetry tapes, and Table 24 summarizes the coverage provided by these tapes.

c. Real-Time Computer Facility (RTCF) Ranger VIII support. The RTCF, which used the 3600 computer in support of a *Ranger* mission for the first time, provided the following computations:

L + 15 min Orbital elements and injection conditions

Table 24. Summary of AFETR Ranger VIII telemetry tapes received at JPL

Station no.	Location	Re- ceiver	Data coverage (GMT)	Data quality	ODC no.
71/TEL-2	Cape Kennedy	Agena	170440-171300	Excellent	A002
	Cape Kennedy	L-band	153100-171245	Excellent	A001
71/TEL-3	Cape Kennedy	Agena	165800-171300	Excellent	A001
	Cape Kennedy	L-band	165800-171250	Excellent	A001
3	Grand Bahama	Agena	170543-171320	Excellent	A012
		L-band	—	—	—
91	Antigua	Agena	171030-171720	Excellent	A011
		L-band	—	—	—
Timberhitch	Lat. 9°0'N	Agena	171650-172250	Good	A009
(Lima)	Long. 40°30'W	L-band	171651-172252	Good	A009
Twin Falls	Lat. 4°30'N	Agena	172025-172720	Good	A008
(Uniform)	Long. 25°30'W	L-band	172150-172600	Good	A009
12	Ascension	Agena	172520-172852	Excellent	A010
		Agena	172928-173010	Excellent	A010
		L-band	172530-172842	Excellent	A010
		L-band	172945-173200	Excellent	A010
Sword Knot	Lat. 0°30'S	Agena	172520-173005	Good	A013
(Yankee)	Long. 5°30'W	L-band	172400-173000	Good	A004
13	Pretoria	Agena	Not received at	—	—
		L-band	JPL as of 2/26/65	—	—

L + 35 min	Orbital elements and injection conditions of the transfer orbit using nominal second-burn DSIF look angles
L + 43 min	Carnarvon look angles
L + 44 min	Orbital elements and injection conditions of the actual transfer orbit (Station 13 data) DSIF look angles
L + 69 min	Orbital elements and transfer orbit (Carnarvon data)
L + 130 min	Orbital elements and parking orbit (Twin Falls data)
L + 156 min	Multi-station solution and pre-retro
L + 227 min	Multi-station solution and post-retro
L + 310 min	Refined post-retro I matrix

Tracking data were transmitted to JPL, at Hangar AO from Bermuda, Grand Turk, Twin Falls, Ascension, Pretoria, and Carnarvon.

d. Ranger IX C-band radar systems coverage. All committed *Ranger* radars' tracking data and metric data were relayed through JPL/ETR communications center to JPL at Pasadena in a timely manner. Antigua data were used by the AFETR real-time computer facility for the computation of the parking orbit, which was also relayed to JPL at Pasadena at the anticipated time.

Radar 1.16 (Cape Kennedy) data were not reducible from L + 59 to L + 61 seconds because of anticipated low and fluctuating receive signal.

Radar 7.180 (Grand Turk) did not obtain reducible data from L + 234 to L + 245 sec because of the anticipated low and fluctuating received signal level.

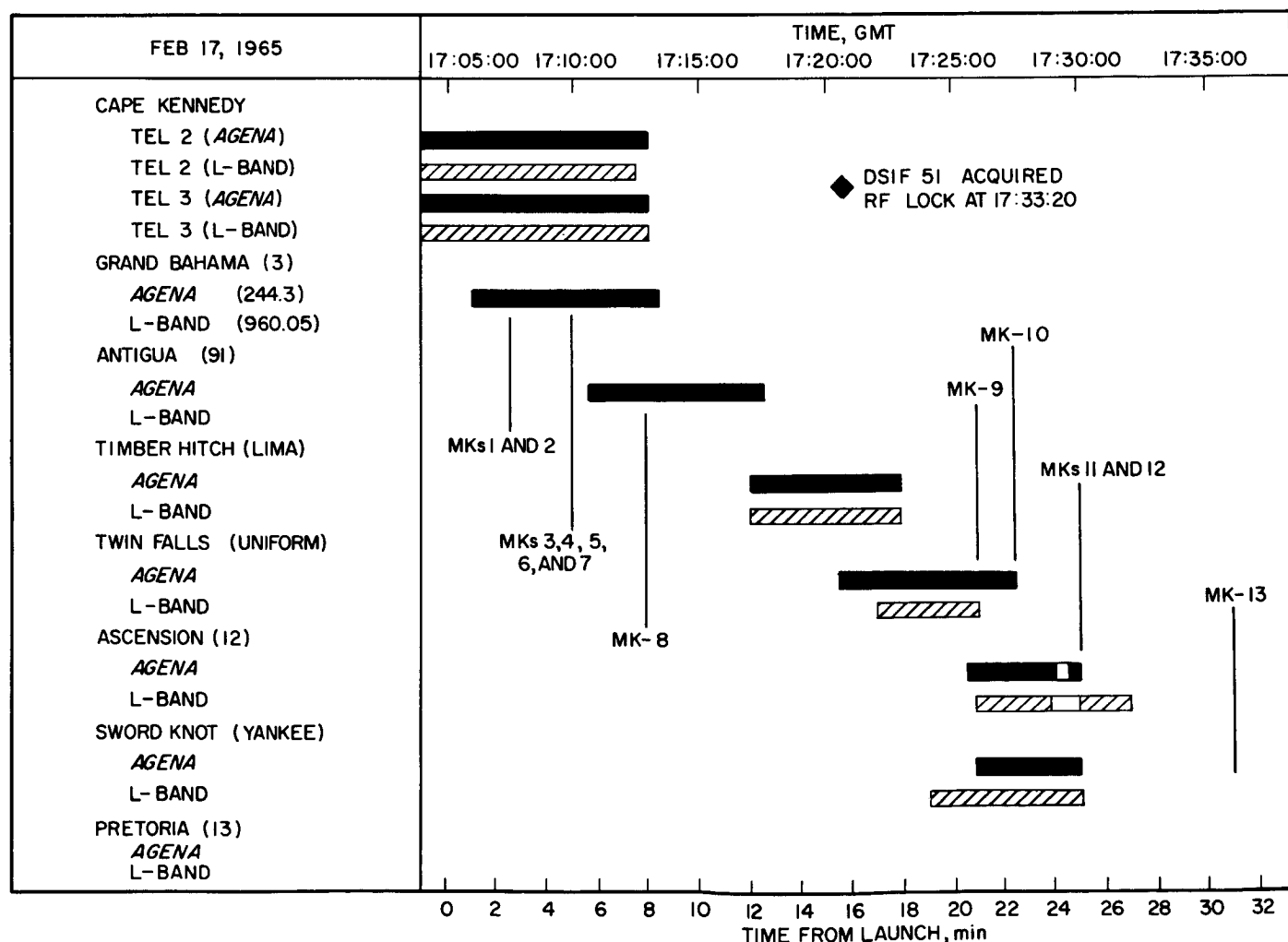


Fig. 51. AFETR telemetry coverage for *Ranger VIII*

Radar 3.16 (Grand Bahama Island) did not obtain data from L + 85 to L + 139 sec. A transmitter on-time (L + 65 sec), the radar 3.18 transmitter came up a full interval (205K yard) away from the radar 3.18 position. This was in approximately the radar 3.16 position. The facing controller phased radar 3.18 through radar 3.16. During the phasing shift, radar 3.16 was knocked off track. At L + 80 sec radar 3.16 locked on to an unidentified return. The radar did not see its own return until L + 135 sec. The radar reacquired automatic track at L + 139 and tracked satisfactorily to L + 490 sec. Radar 3.18 phasing drift and position checks were satisfactory prior to launch minus zero.

Radar 3.18 could not maintain automatic track prior to L + 311 sec. Several attempts were made to lock on to the beacon from L + 69 to L + 298 seconds. When the target was placed in the beacon gate and automatic track attempted, the gate would reject the target and the angles would slew off. Automatic skin track was attempted and acquired at L + 311 seconds. At L + 360 sec, the skin return faded and reacquisition of the beacon was attempted. The beacon return was locked up and held for 1 sec and the radar slewed off. Beacon track was tried again, locked up, held for 2 sec, and the radar slewed off. At L + 403 sec, beacon lock-up appeared solid and the radar maintained automatic track to L + 453 seconds with all indications normal. The beacon return faded at L + 453 sec. Site and engineering checks completed after the mission did not reveal the cause of the problem. Aircraft were tracked following the mission with no problems. The radar has operated satisfactorily in all subsequent tests.

Radar 3.16 data were not reducible from L + 158 to L + 162 sec. The cause of the loss has not been determined.

e. Ranger IX telemetry coverage. Spacecraft telemetry was received by AFETR Station 1, Tel-3, Cape Kennedy; Station 12 (Ascension); Station 13 (Pretoria), and by Range Instrumentation Ships (RIS), Yankee and Uniform. Coverage intervals were from prior to lift-off to L + 472 sec, L + 685 to L + 2319 sec, L + 2350 to L + 2900 sec, L + 2930 sec to L + 3235 sec, L + 3260 to L + 3445 sec, and from L + 3455 to L + 4139 sec.

RIS Sword Knot did not acquire link 960.5 Mc. Pre-amp gain checks and radiation through the system following the mission failed to reveal any malfunction. After these checks, the 960-Mc antenna was removed from the TAA-1 pedestal and a step-by-step system check was performed. This check revealed that there was a defective collectual connector in the coax line from the 960-Mc rack

to the TAA-1 console. The defective connector was believed to be the cause of the problem.

Launch vehicle telemetry was received by AFETR Station 1 (Cape Kennedy); Station 3 (Grand Bahama Island); Station 91 (Antigua); Station 12 (Ascension); Station 13 (Pretoria); and by RIS Yankee and Uniform. The overall coverage was continuous from prior to lift-off to L + 4129 sec.

The 98 kc sub-carrier on link 244.3 from Station 91 (Antigua) was not provided to Hangar AO. The data were to be transmitted to Hangar AO by Tel-2. Station 91 (Antigua) was feeding the subcable but the signal was not being received by Tel-2. The cause of the problem was not determined.

The telemetry tapes recorded and provided by AFETR varied in quality, but were, for the most part, satisfactory. AFETR provided continuous telemetry coverage from lift-off until L + 30.5 min (220735) when Ascension lost lock. Telemetry was picked up again by Pretoria at L + 55 min (222200) with lock lost at L + 68 min (224500).

There was little difference in the data quality recovered from the *Agena* subcarrier, 244.3 Mc, and the L-Band subcarrier, 960.05 Mc, when both were recorded. However, the *Agena* subcarrier was the only telemetry source from Tel-3 loss of lock at L + 8 min (214445) until Ascension RF lock at L + 16.5 min (215340). Figure 52 shows the coverage provided by the telemetry tapes and Table 25 summarizes the tapes received from AFETR.

Table 25. Summary of AFETR Ranger IX telemetry tapes received at JPL

Station no.	Location	Receiver	Data coverage (GMT)	Data quality	ODC no.
71/TEL-2	Cape Kennedy	<i>Agena</i>	213730-214450	Excellent	A001
71/TEL-3	Cape Kennedy	<i>Agena</i>	213700-214450	Good	A002
	Cape Kennedy	L-band	213700-214445	Excellent	A002
3	Grand Bahama	<i>Agena</i>	213750-214515	Fair	A011
91	Antigua	<i>Agena</i>	214300-214805	Excellent	A012
Timberhitch (Lima)	Lat. 16°30'N Long. 50°0'W	<i>Agena</i>	214530-215210	Good	A019
Twin Falls (Uniform)			Not received at JPL as of 4/8/65		
Sword Knot (Yankee)	Lat. 8°30'N Long. 24°0'W	<i>Agena</i>	215100-215540	Noisy	A015
		L-band	215230-215800	Noisy	A015
12	Ascension	<i>Agena</i>	215400-220629	Fair	A013
		L-band	215340-220735	Fair	A013
13	Pretoria	L-band	222200-224500	Good	A016 A018

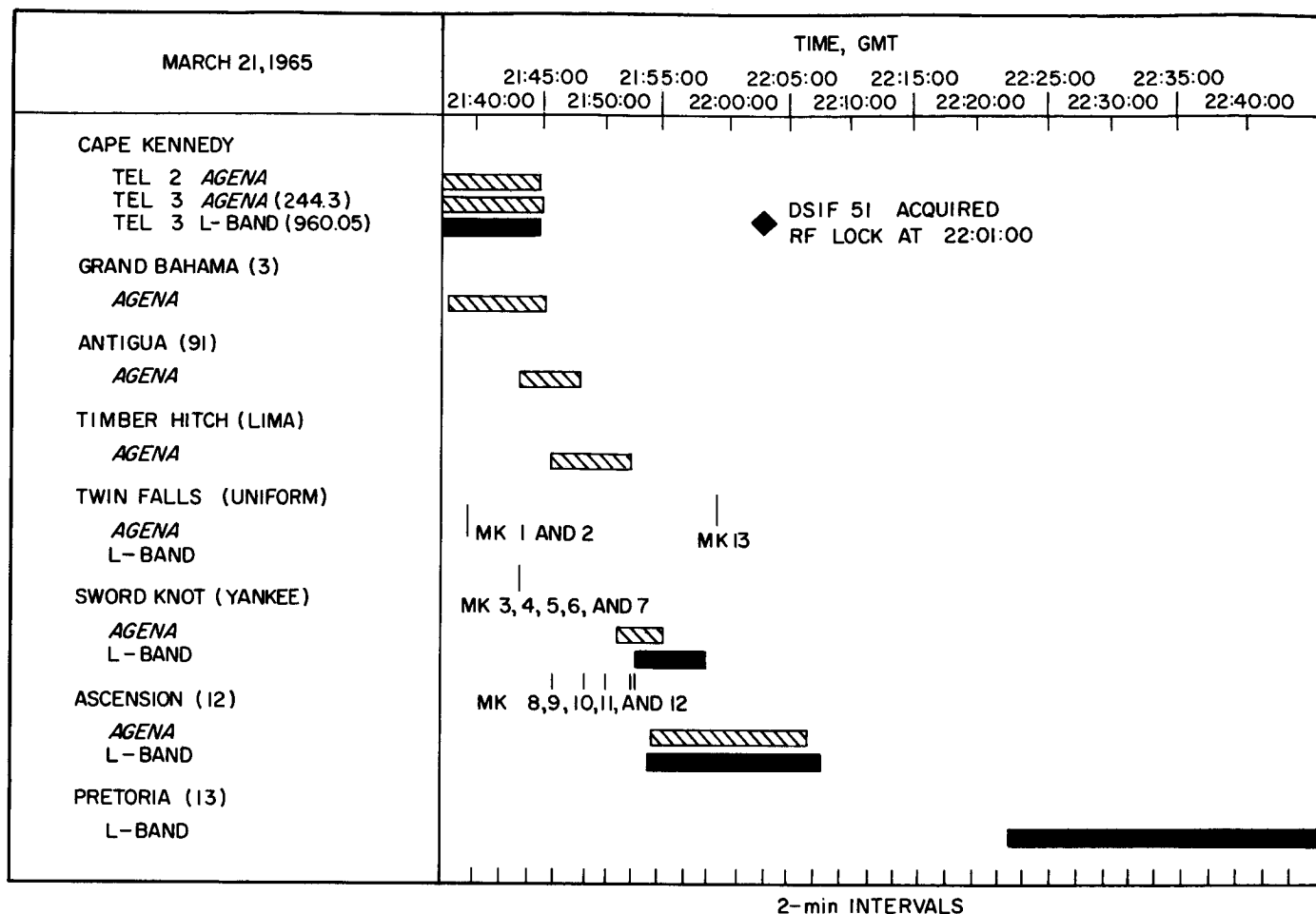


Fig. 52. AFETR telemetry coverage for Ranger IX

f. Real-time computer facility (RTCF) Ranger IX support. Two problems were experienced when both 3600 computers of the RTCF failed as a result of instruction parity errors at the start of transmission of DSIF acquisition information; this information was based on the parking orbit of approximately L + 15 min. The RTCF was down about 4 min, which resulted in delay of approximately 5 min on the transmission of this information. Two sets of DSIF-51 look angles and one set of DSIF-41 look angles were computed from the parking orbit and transmitted to JPL in Pasadena.

The 3600 A computer failure was due to instruction parity error. Upon the failure of the A computer, the back-up 3600 B computer was put in operation, but unfortunately the TTY outputs were not changed and approximately 4 min elapsed before that error was discovered and the change made. The parity error problem was presently being solved through an executive routine modification. Total time lost was 10 min on the A computer and 4 min on the B computer.

The actual transfer orbit message was approximately 4 min late. It was computed from post-retro Ascension data because pre-retro data were not readily available as a result of the RTCF failure. The DSIF acquisition information based on this orbit was about 3 min late. Two sets of DSIF-51 look angles and one set of DSIF-41 look angles were again computed and transmitted to JPL. Several single-station solutions were then computed in rapid succession, using Twin Falls, Ascension (pre-retro) and Pretoria (post-retro) data.

These were followed by multi-station solutions, which used Twin Falls and Ascension data for pre-retro orbit, and Ascension and Pretoria data for a post-retro orbit. A bias was at first suspected in the Ascension data, however, the multi-station solutions did not bear this out.

g. Goddard Space Flight Center Ranger VIII and IX support. The Manned Space Flight Network (MSFN) was

assigned as the lead division within GSFC to provide the T&DA support for the *Ranger VIII* and *IX* missions. The MSFN stations providing this support were Bermuda, Carnarvon, and Tananarive. Telemetry through the *Agna* and metric support for range safety were provided by Bermuda. VHF telemetry and FPQ-6 radar support were

provided by Carnarvon. VHF telemetry support was provided by Tananarive.

Carnarvon lost track on the C-Band beacon after 10 min, otherwise the stations reported good reception and normal operation throughout the missions.

ABBREVIATIONS

AFETR	Air Force Eastern Test Range	M/C	<i>Mariner C</i>
AGC	automatic gain control	MSFN	Manned Space Flight Network
AMR	Atlantic Missile Range	NASA	National Aeronautics and Space Administration
DEC	declination	ODC	orbit determination code
DSIF	Deep Space Instrumentation Facility	ODP	orbit determination program
DSN	Deep Space Network	OVCS	operational voice control system
FPAC	Flight path analysis and command	PDBL	precision doppler bias loop
GCS	ground communications system	RTCF	real-time computer facility
GMT	Greenwich mean time	RWV	read-write-verify
GSDS	Goldstone duplicate standard	SAA	S-band acquisition antenna
GSE	ground support equipment	SDAT	spacecraft data analysis team
GSFC	Goddard Space Flight Center	SFOF	Space Flight Operations Facility
HA	hour angle	STADAN	Satellite Tracking and Data Acquisition Network
IGOR	intercept ground optical recorder	T&DA	tracking and data acquisition
JPL	Jet Propulsion Laboratory	TM	telemetry
LNA	low noise amplifier	TPS	telemetry processing station
LO	local oscillator	TTY	teletypewriter
MASER	microwave amplification by stimulated emission of radiation	VCO	voltage-controlled-oscillator

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- Schurmeier, H. M., and Staff, *Ranger VII, Mission Description and Performance, Part 1*, Technical Report No. 32-700, December 15, 1964.
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APPENDIX

Operations Summary for Ranger Missions VI through IX

I. RANGER VI OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-1 - A-8) for the *Ranger VI* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary in the form of edited station logs. Throughout the summary (Table A-1) the space communication stations of the DSIF are identified by the following location designations:

DSIF-11 Pioneer Station, Goldstone, California

DSIF-12 Echo Station, Goldstone, California

DSIF-41 Woomera Station, Australia

DSIF-51 Johannesburg Station, South Africa

DSIF-59 Mobile Tracking Station, Johannesburg, South Africa

DSIF-71 Spacecraft Monitoring Station, Cape Kennedy, Florida

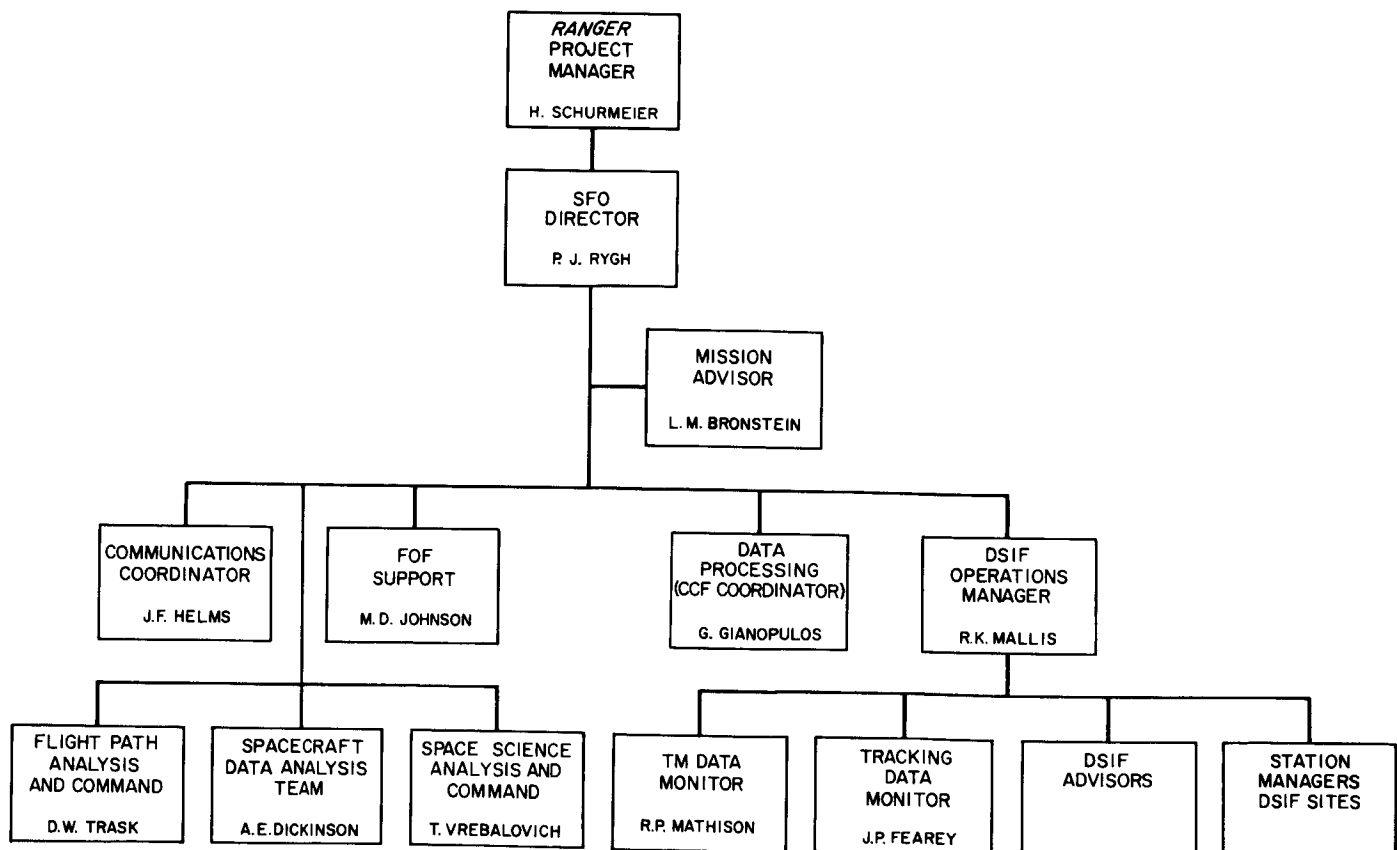


Fig. A-1. Space flight operations organization for *Ranger VI*

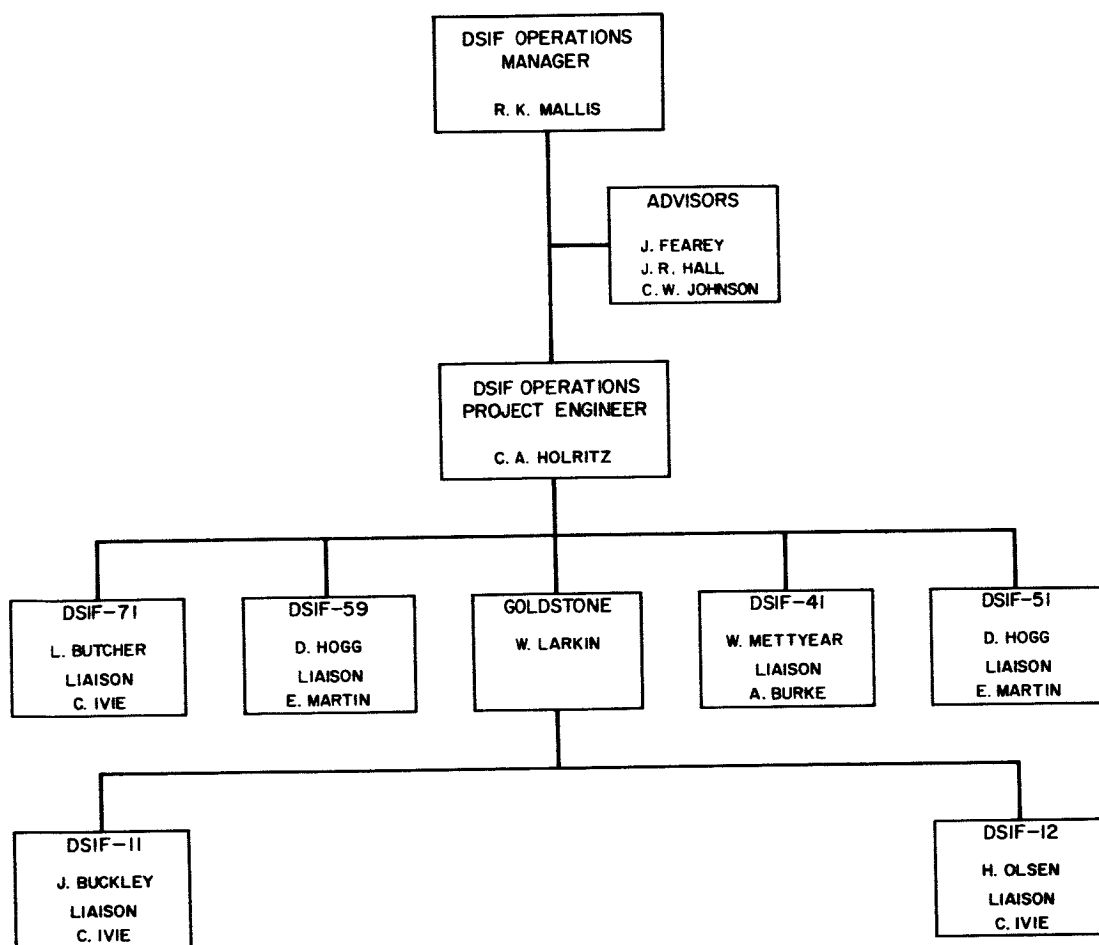


Fig. A-2. DSIF operations organization for *Ranger VI*

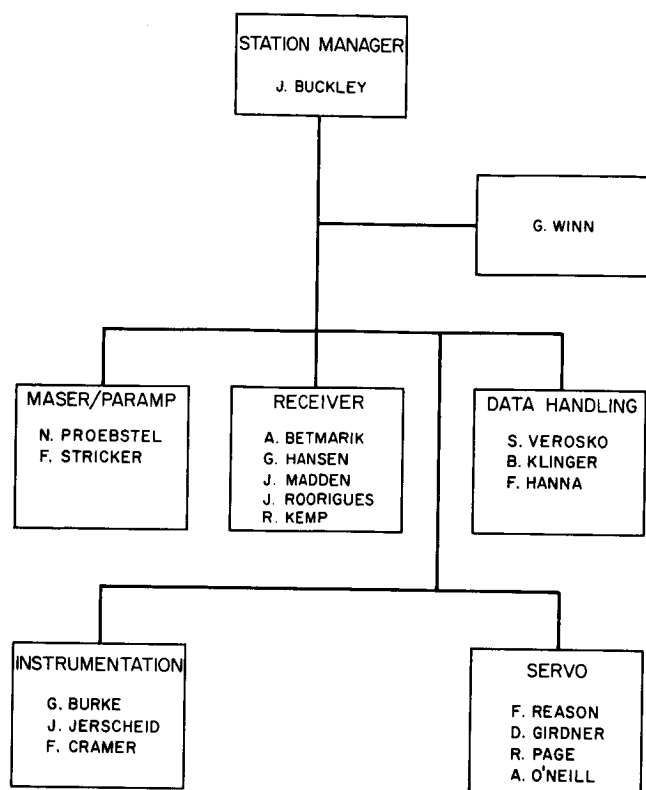


Fig. A-3. DSIF-11 organization for Ranger VI

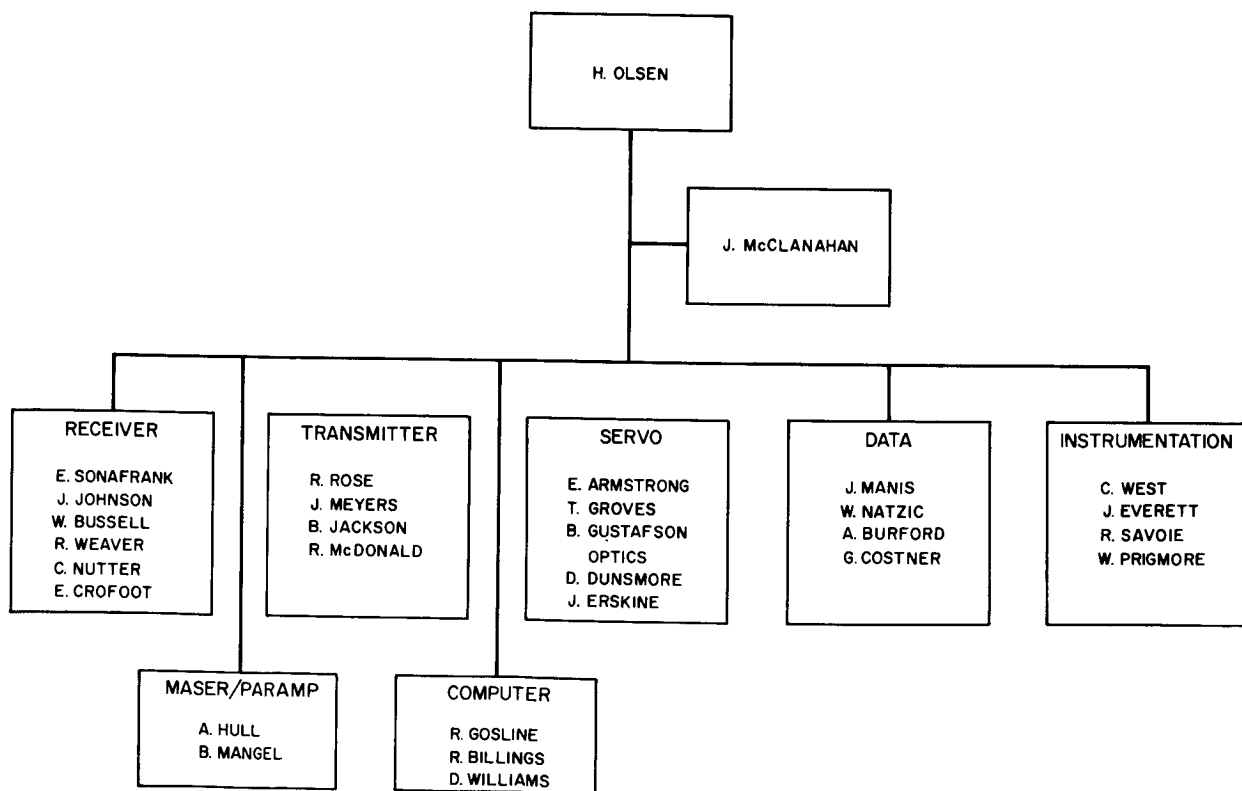
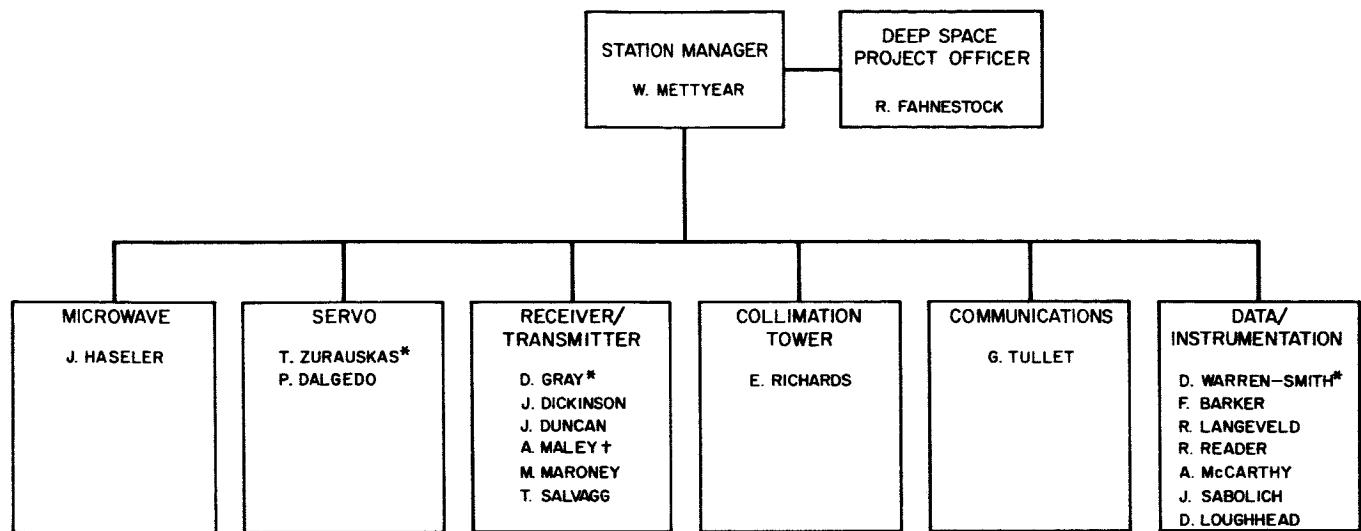
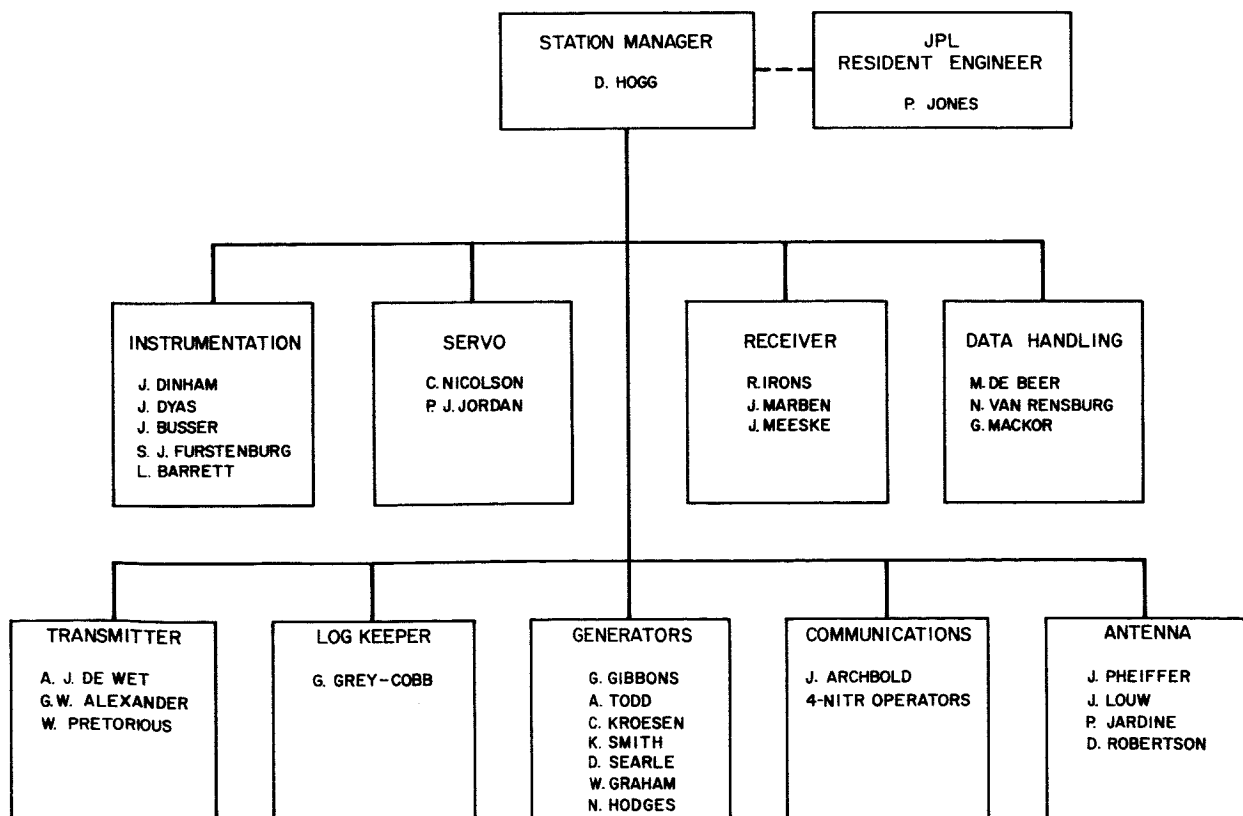


Fig. A-4. DSIF-12 organization for Ranger VI



* SECTION LEADER
† OPERATIONS SUPERVISOR

Fig. A-5. DSIF-41 organization for *Ranger VI*Fig. A-6. DSIF-51 organization for *Ranger VI*

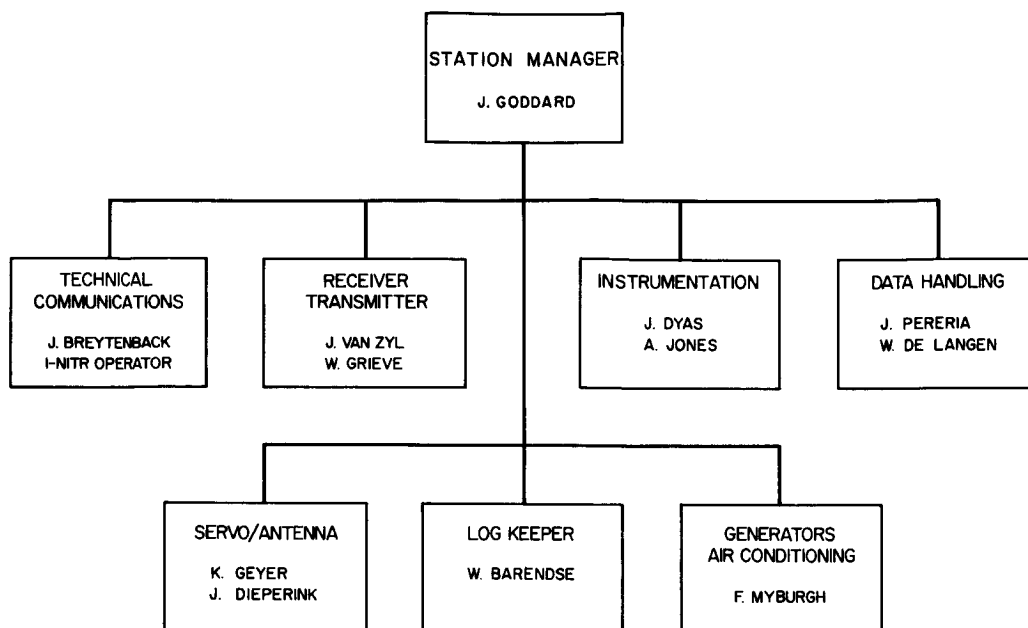


Fig. A-7. DSIF-59 organization for Ranger VI

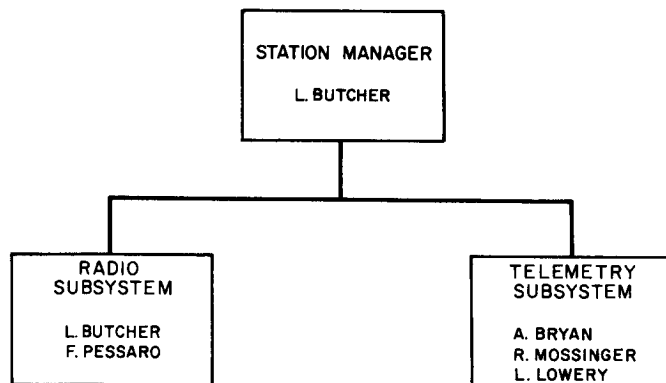


Fig. A-8. DSIF-71 organization for Ranger VI

II. RANGER VII OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-9-A-16) for the *Ranger VII* space flight operations, DSIF operations, and individual station management. Included also is a tracking operations summary (Table A-2) in the form of edited station logs. Translations of the number designation identifying each DSIF station in the logs are provided in Section 1 of this Appendix.

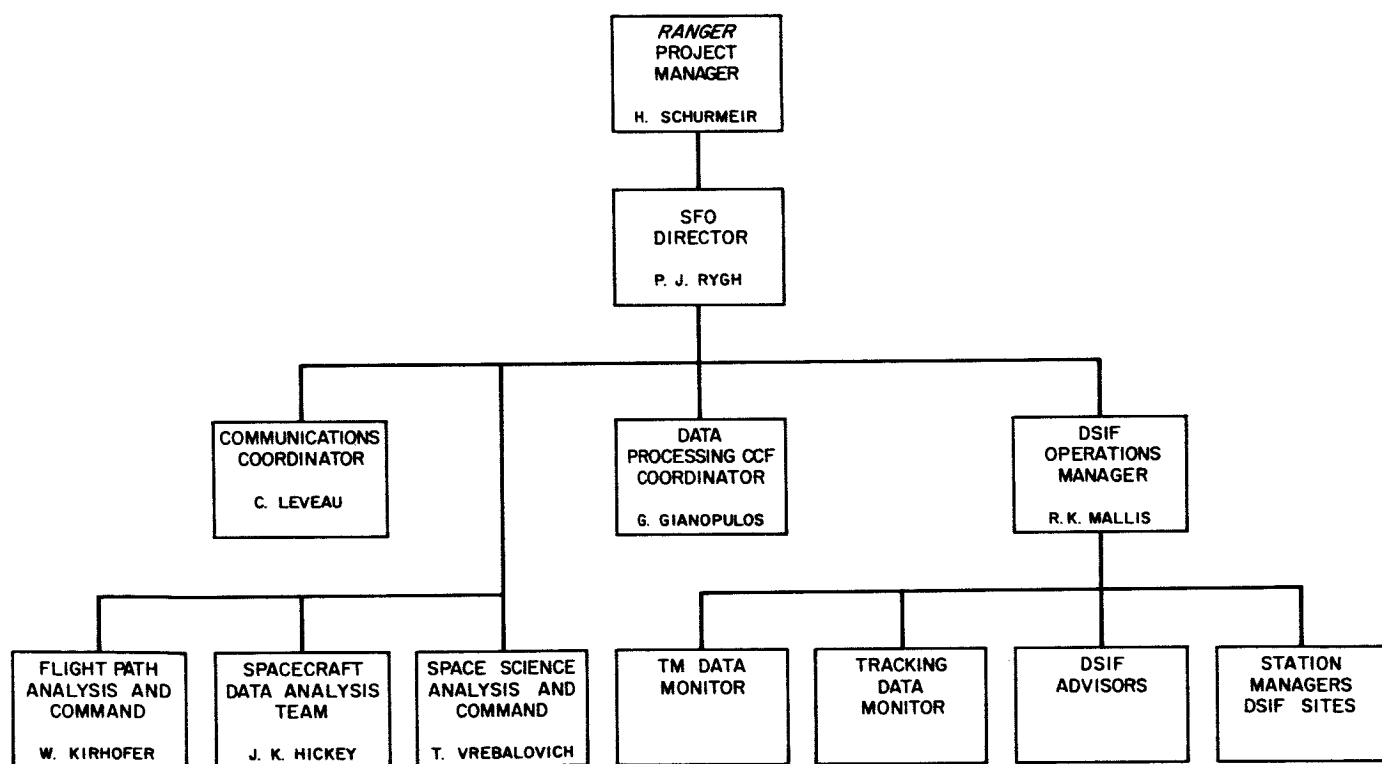


Fig. A-9. Space flight operations organization for Ranger VII

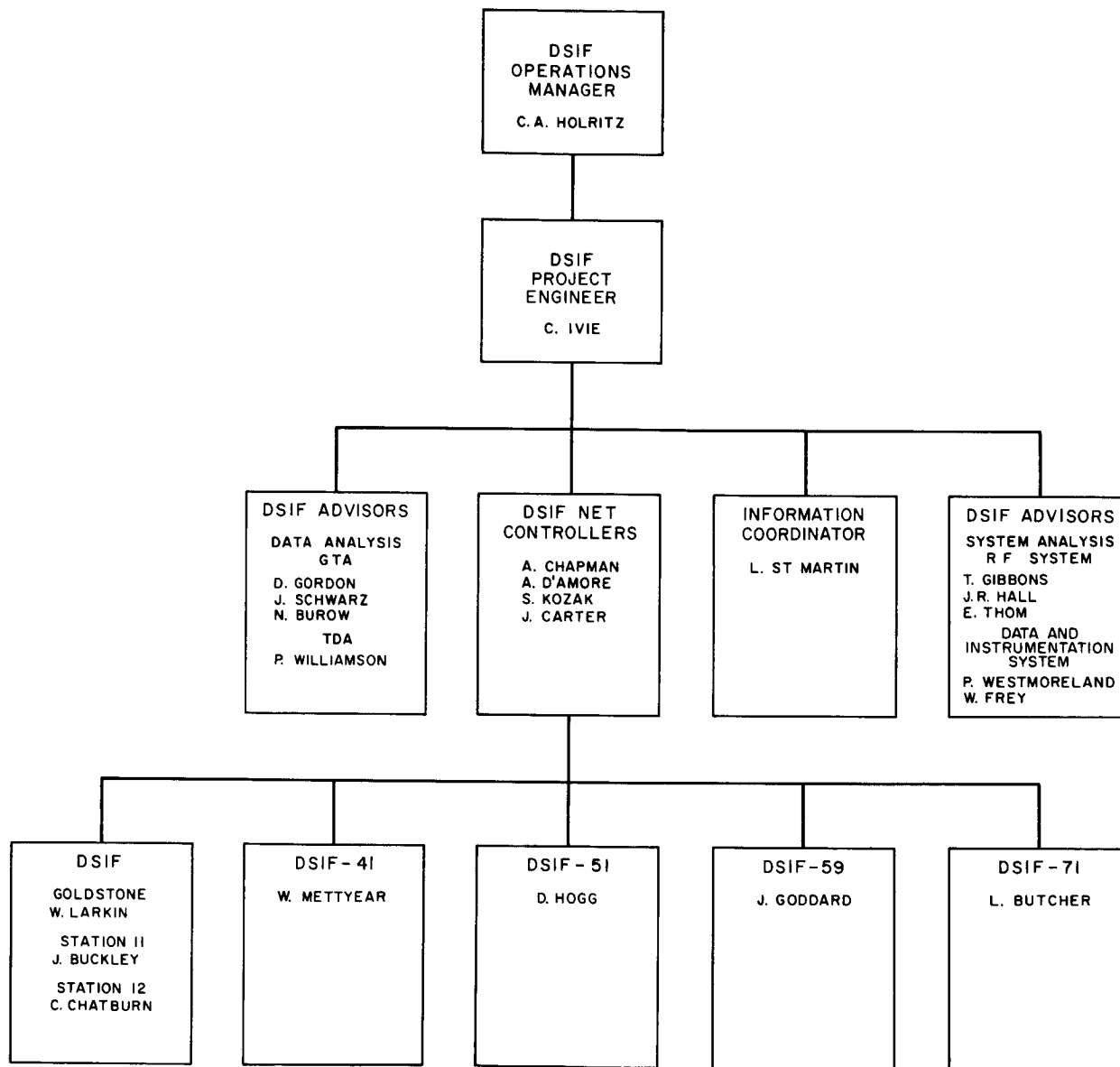
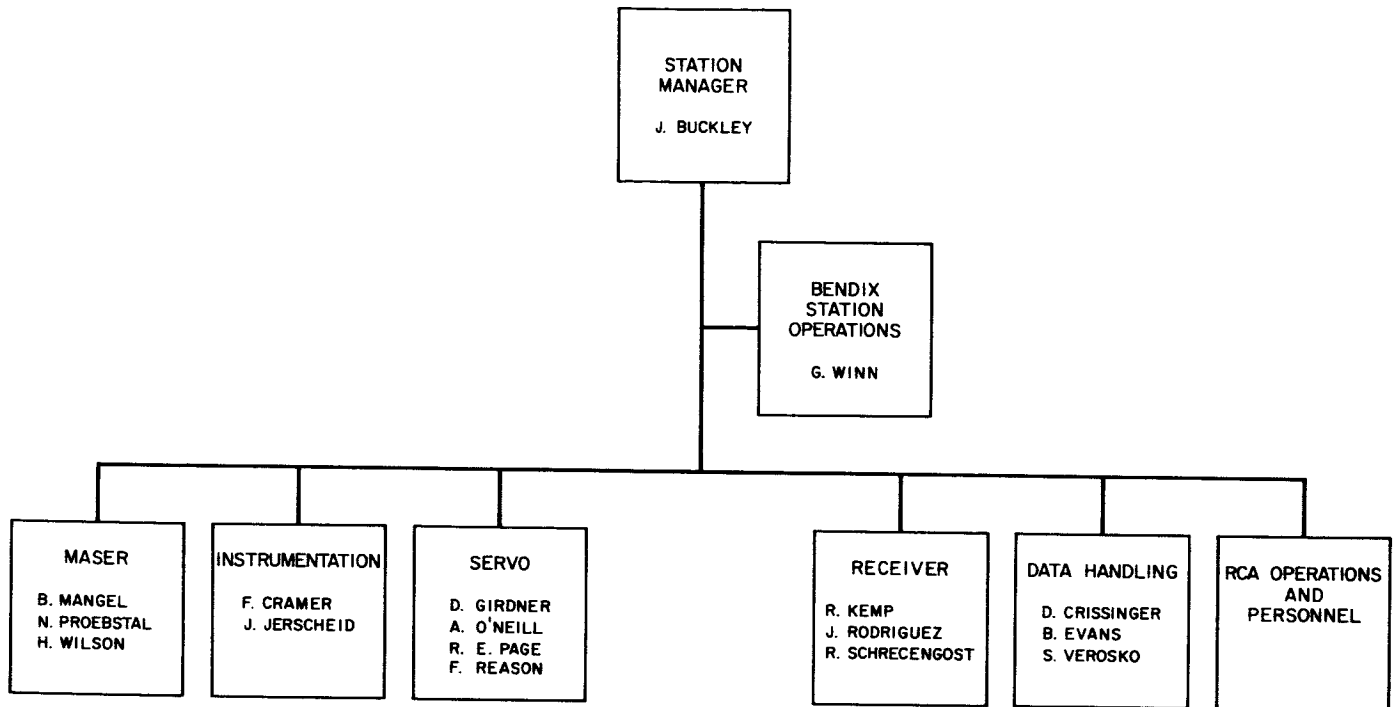
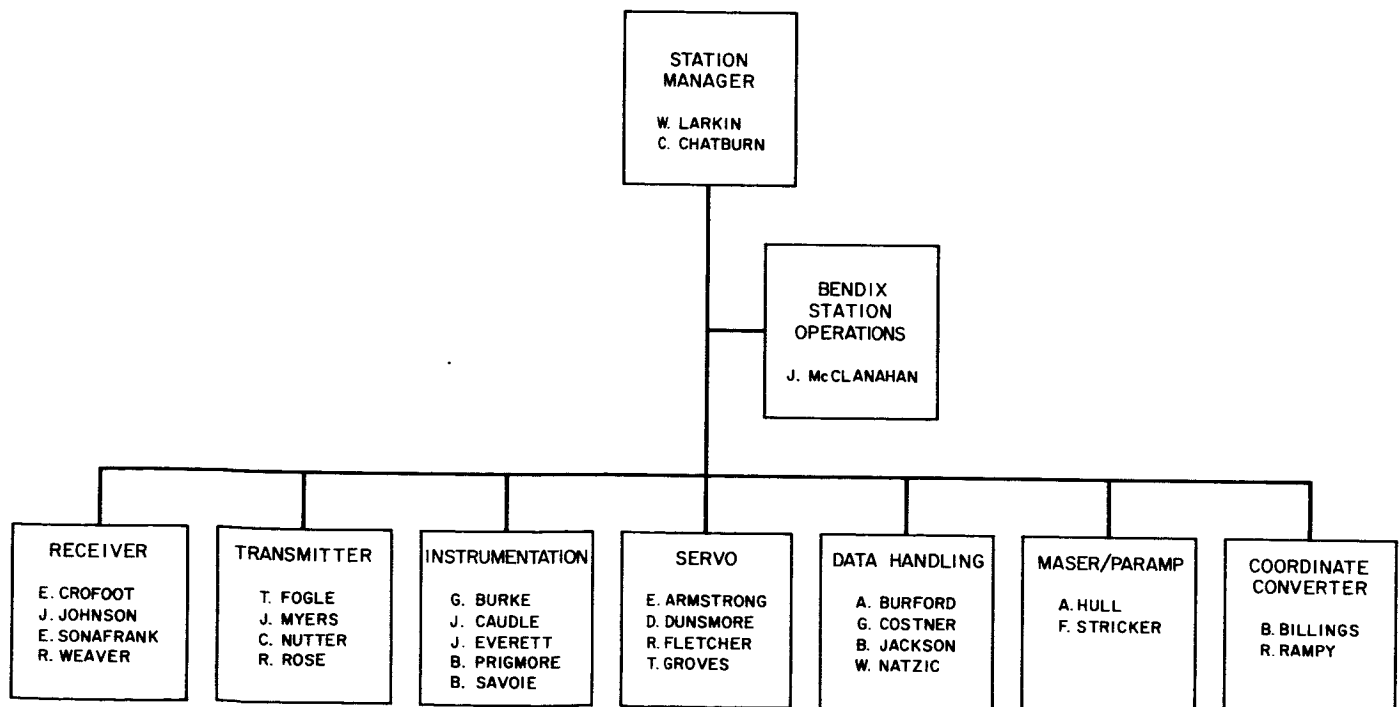


Fig. A-10. DSIF operations organization for *Ranger VII*

Fig. A-11. DSIF-11 organization for *Ranger VII*Fig. A-12. DSIF-12 organization for *Ranger VII*

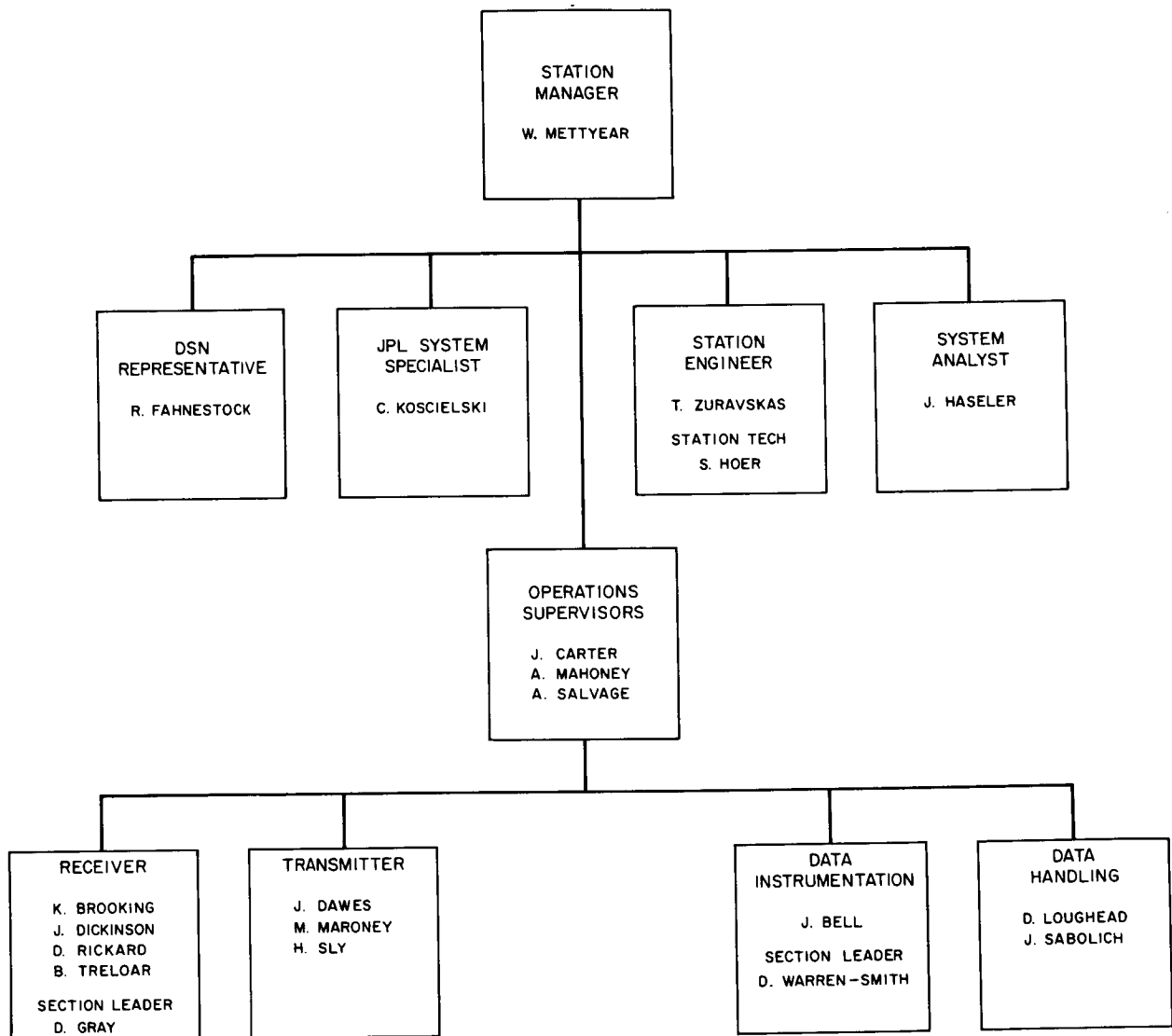


Fig. A-13. DSIF-41 organization for Ranger VII

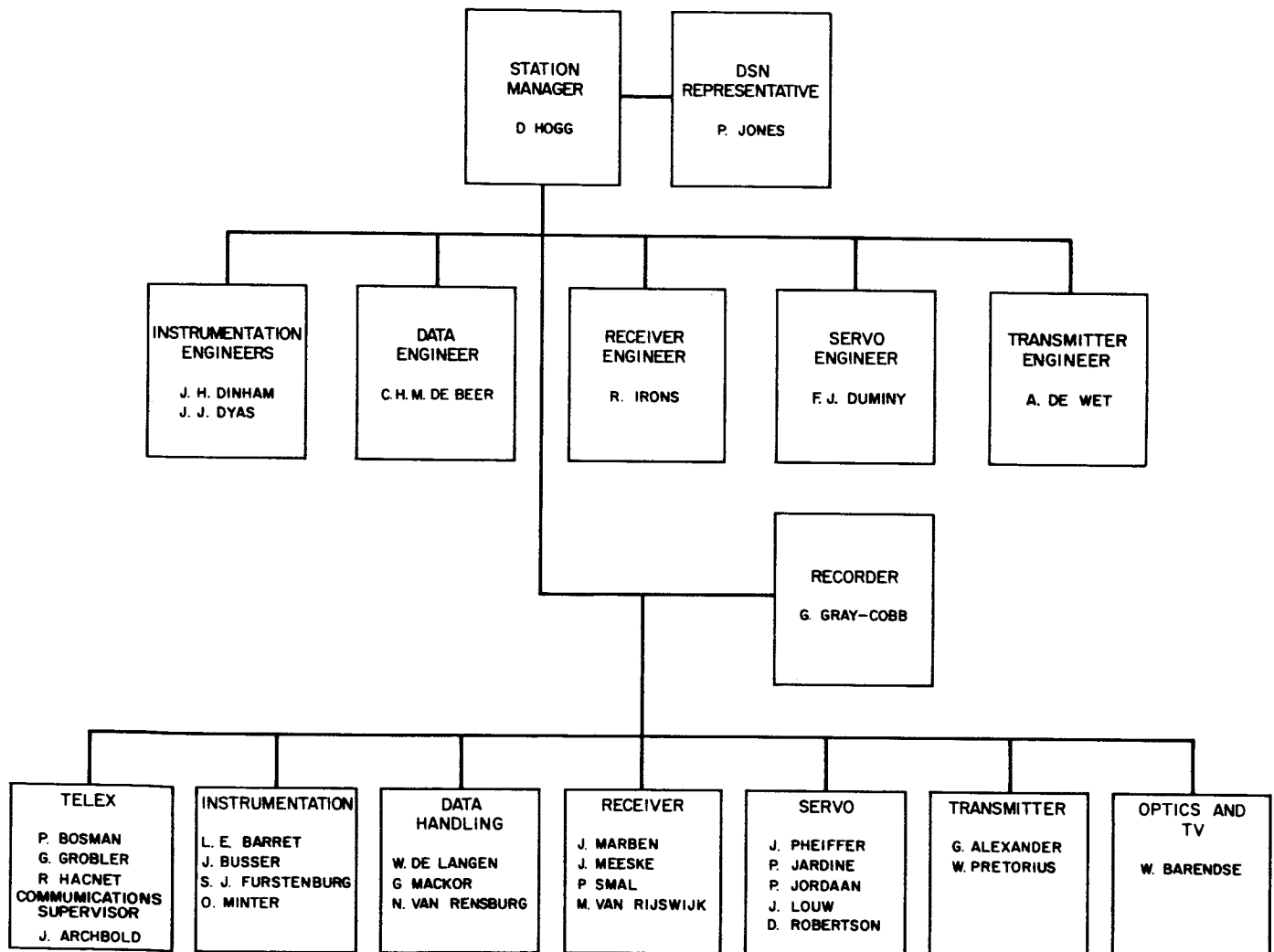
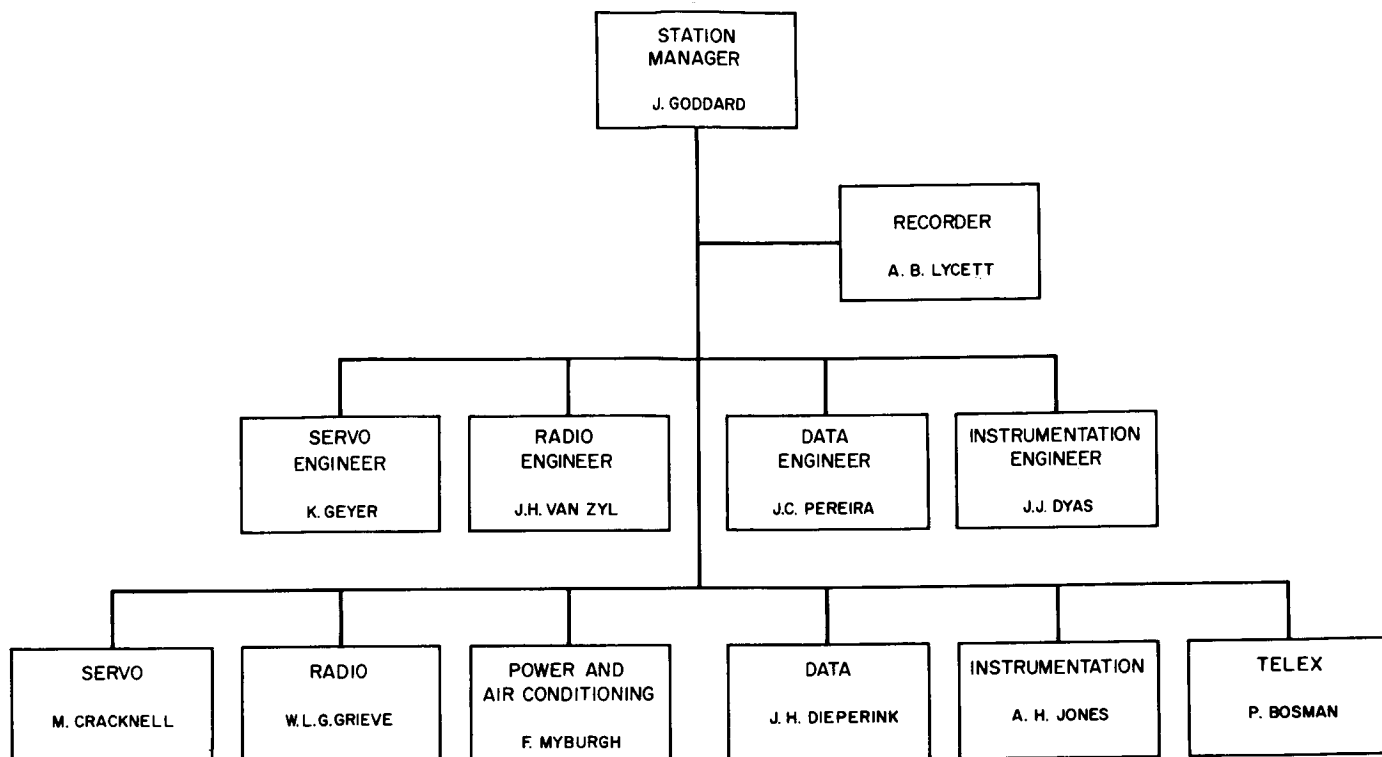
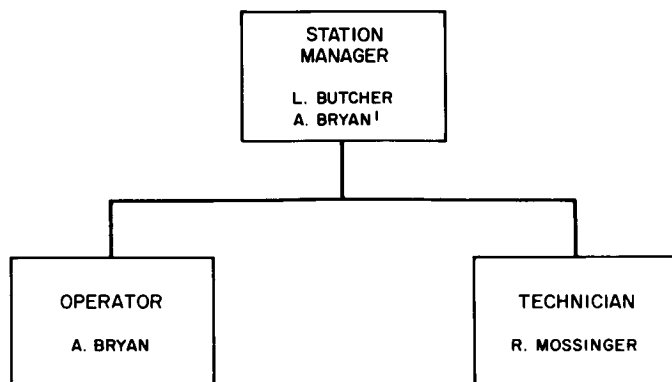


Fig. A-14. DSIF-51 organization for Ranger VII

Fig. A-15. DSIF-59 organization for *Ranger VII*¹ A. BRYAN, ACTING STATION MANAGER FOR *RANGER VII*Fig. A-16. DSIF-71 organization for *Rangers VII, VIII, and IX*

III. RANGERS VIII AND IX OPERATIONS SUMMARY

This section contains organizational charts (Fig. A-17-A-21) for the *Rangers VIII* and *IX* space flight operations, DSIF operations, and individual station management. A tracking operations summary, in the form of edited station

logs (Tables A-3 and A-4) is also included for both missions as supplemental information. Translations of the number designation identifying each DSIF station in the logs are provided in Section I of this Appendix.

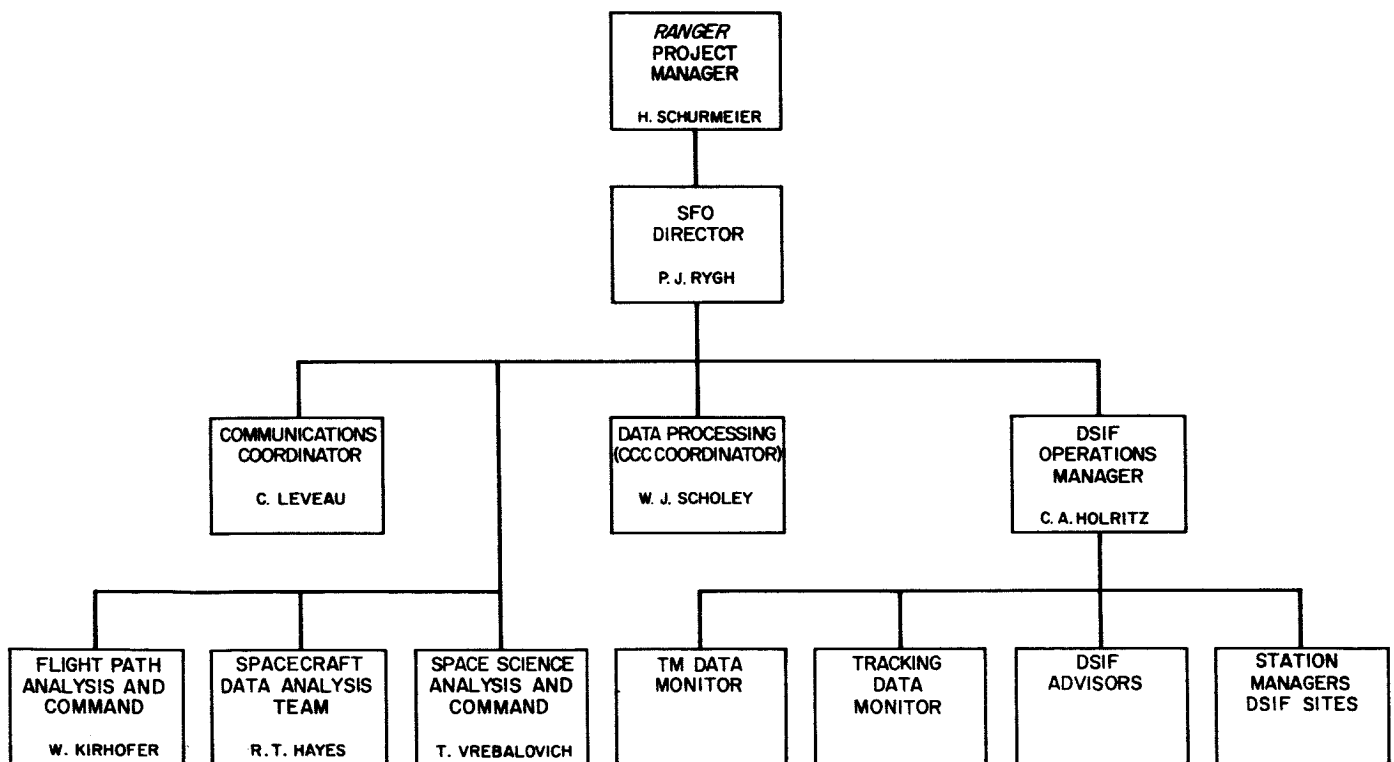
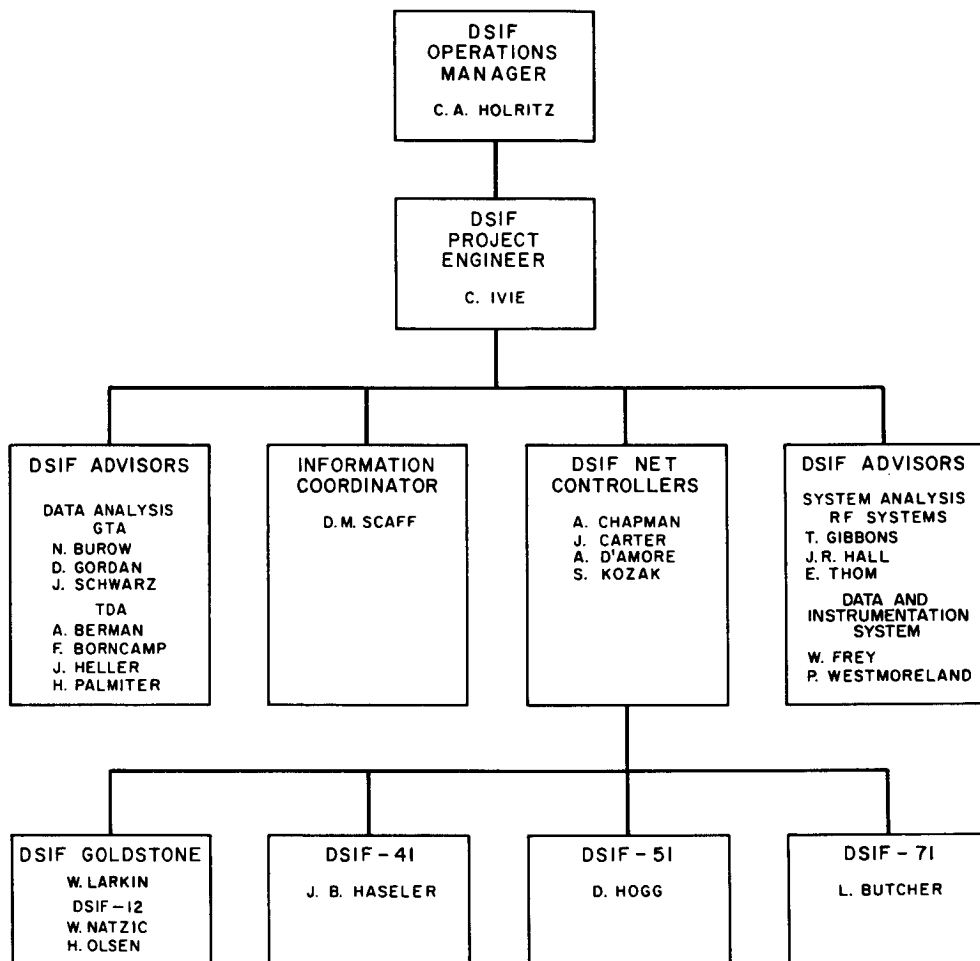


Fig. A-17. Space flight operations organization for *Rangers VIII and IX*

Fig. A-18. DSIF operations organization for *Rangers VIII and IX*

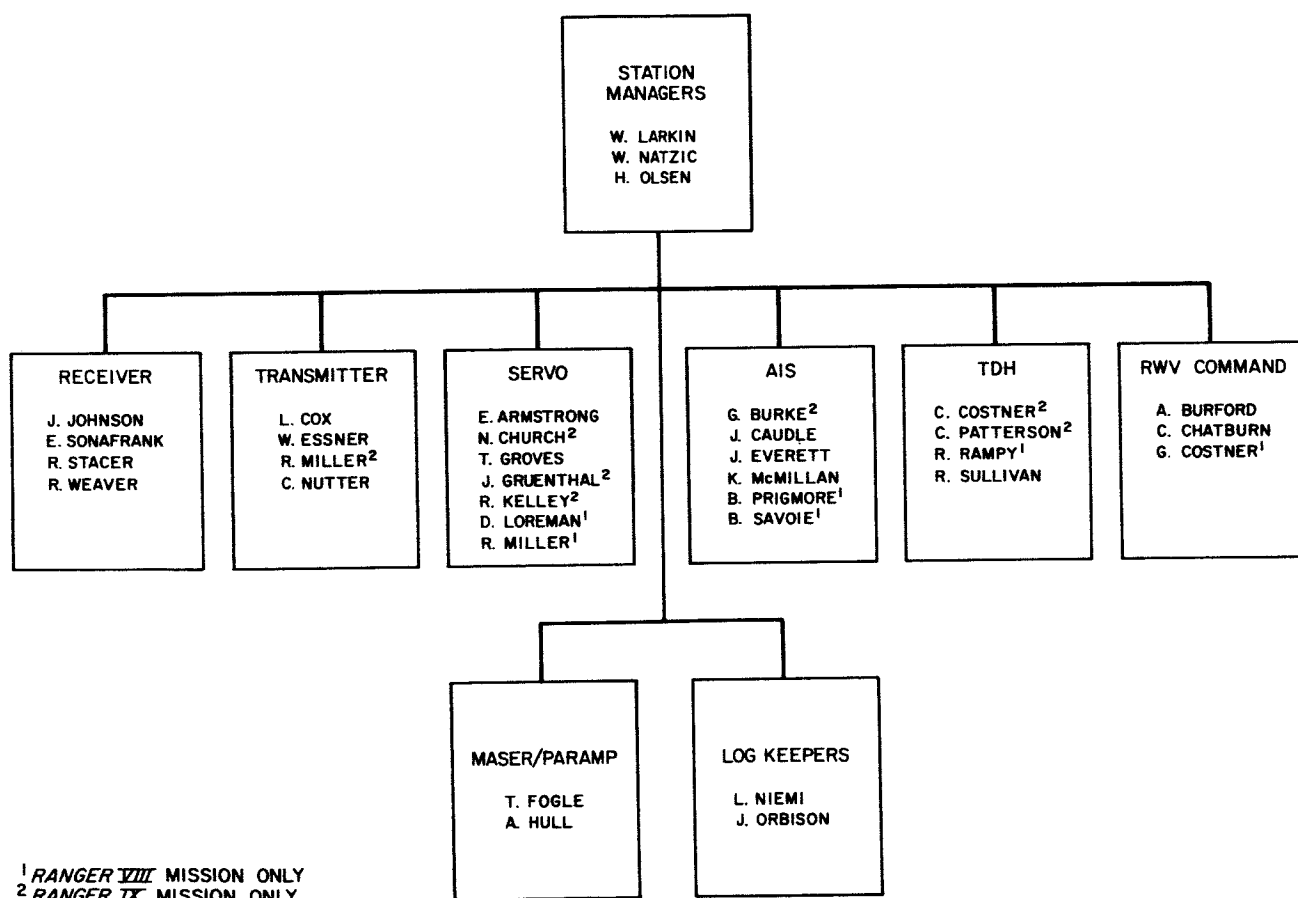


Fig. A-19. DSIF-12 organization for Rangers VIII and IX

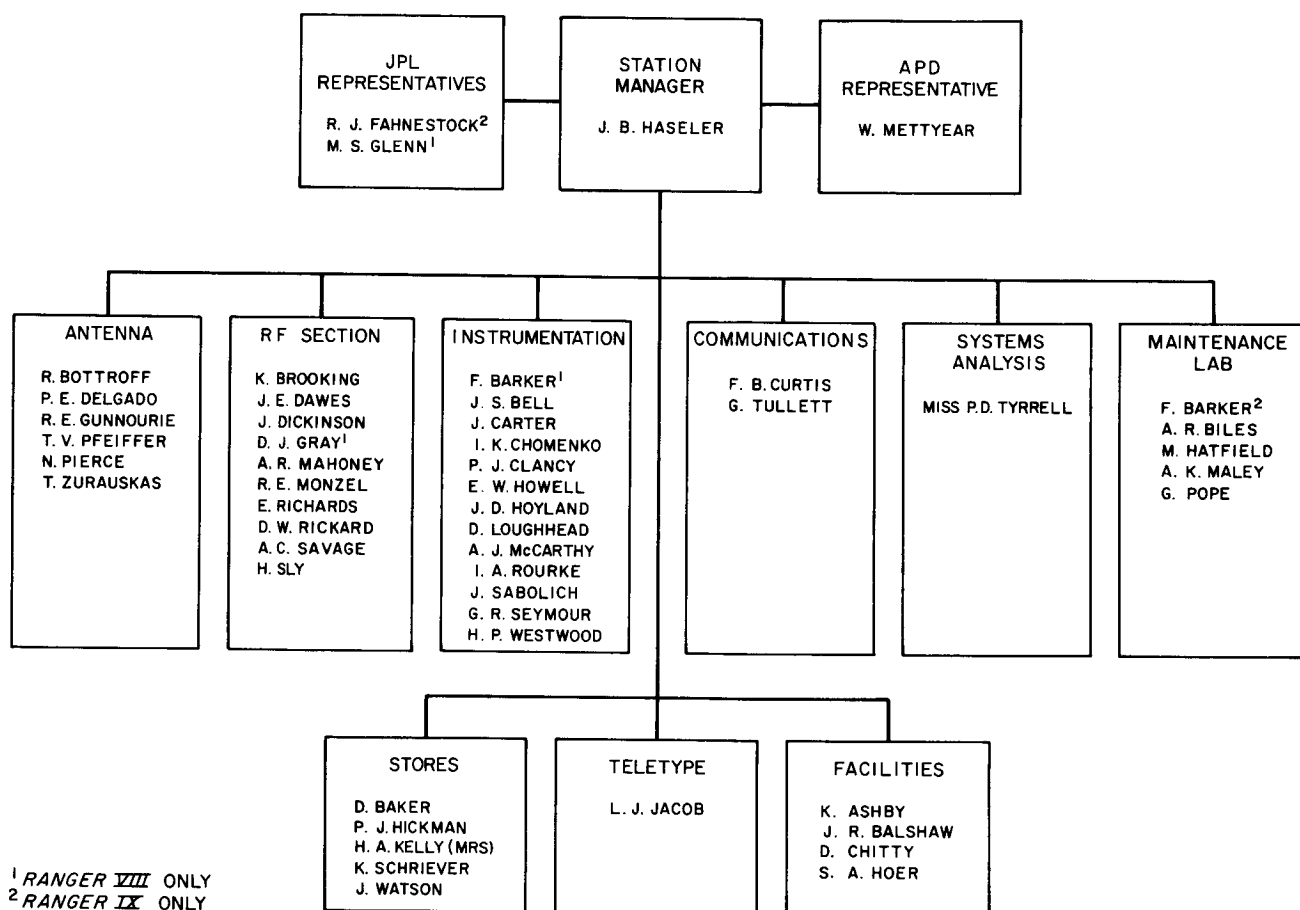
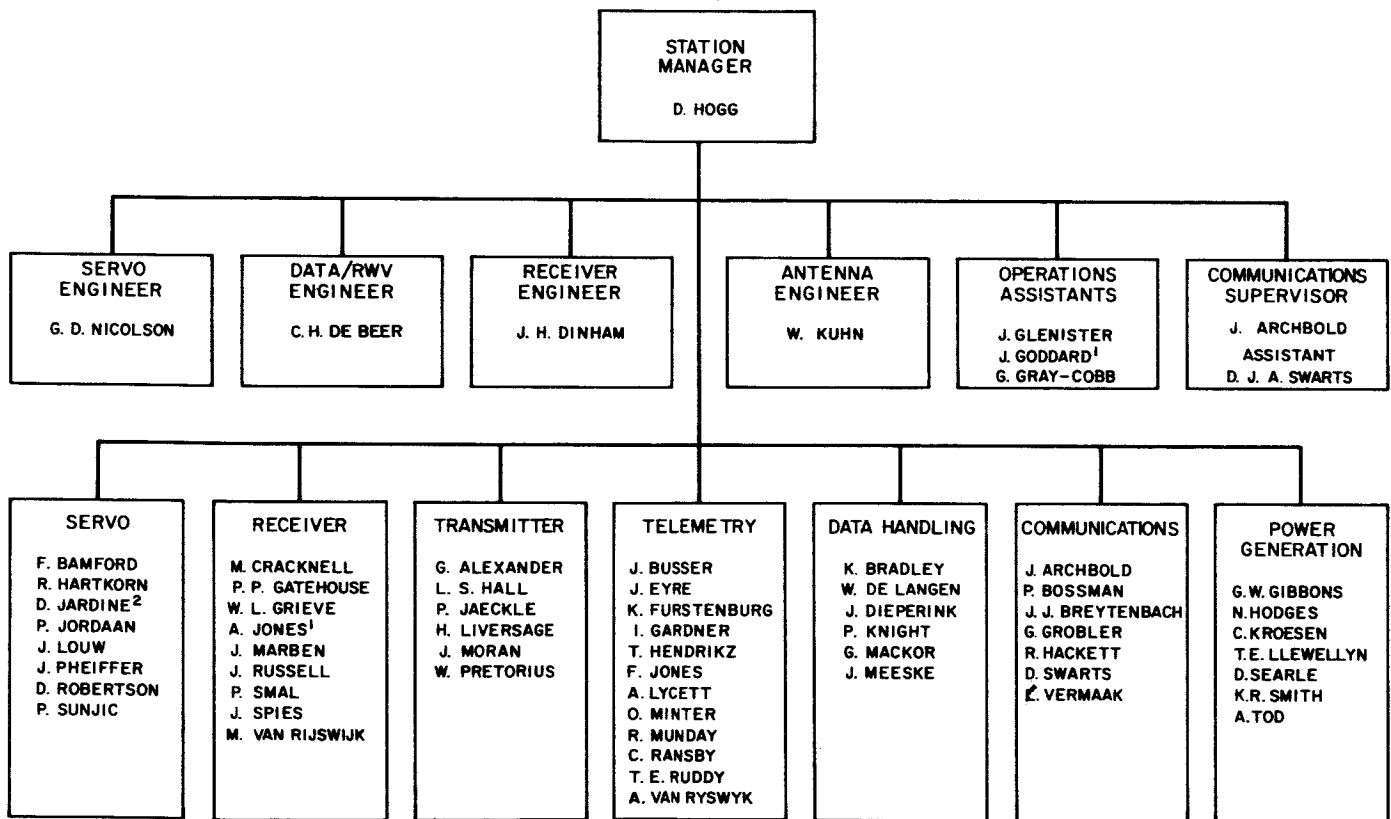


Fig. A-20. DSIF-41 organization for Rangers VIII and IX



¹ RANGER VIII ONLY
² RANGER IX ONLY

Fig. A-21. DSIF-51 organization for Rangers VIII and IX

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 71

VIEW PERIOD: 30/154902 to 30/155700

SIG STR (dbm)	TIME (GMT)	REMARKS
-78	154902	One-way tracking mode; received telemetry only; telemetry conditions good; no changes in station configuration; recorded oscillograph data from L-215 min to 155700; recorded magnetic tape from L-7 min to 155700 Loss of signal
	155700	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 30/161844 to 31/073529

SIG STR (dbm)	TIME (GMT)	REMARKS
	161844	Initial acquisition; Rx in lock
	161856	Servo on auto
-119	161858	No TV
-102	162000	
	162021	Rc out of lock
	162034	Rx in lock
-99	162105	
	162305	Servo to narrow band
-103	162305	
	163048	Rx out of lock
-114	163100	Rx in lock
	163107	Servo to auto
	163346	All channels in lock
	163440	Rx out of lock
	163525	Rx in lock
	163530	Rx out of lock
	163535	Rx in lock
	163548	Rx in pseudo two-way
-117	163550	Servo to auto
	163623	All channels in lock
	163943	Data changing sampling rate to 1 per min
	164214	Rx out of lock
	164217	Rx in lock
	164351	Rx out of lock
-118	164403	Rx in lock
	164500	All channels in lock
	164530	
	164730	
	164800	
	164810	
	164830	
	165040	
	164945	All channels out of lock
	165000	All channels in lock
-127	165004	
	165150	Servo in aided; reached limits
-120	165303	
	165418	B-2-1 blip
-124 to	165700	
-118		
-135 to		
-140		
	165900	Last Channel B-2

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 30/161844 to 31/073529

SIG STR (dbm)	TIME (GMT)	REMARKS
-125 to -127	170000	Channel B-2 in lock
	170053	All channels out of lock
	170115	Rx out of lock
	170317	Recorder off data stopped sampling
	175400	All recorders on; data sampling
	175725	Rx in pseudo two-way
-130	175800	All channels in lock
	180000	Lost Channel 1 - 400 cps
	180100	Channel 1 in lock
	180230	All channels out of lock
	180550	All channels in lock
	180900	RA-30 to DSIF 51
	181000	Servo in auto; Tx VCO frequency 9668211 cps
	181530	Signal level - 132 dbm
	182230	Signal level - 130 dbm
	182400	
-135 -132	183600	Data high speed punch not operational
	184200	Punch repaired
	185100	Punches running away
	185300	Punches operational
	190100	
	190905	Rx out lock momentarily All channels momentarily out of lock
-133 -133	191210	
	192005	An apparent B-2-2 blip was observed
	193600	No more curious pulses on B-2
	200000	Rx out of lock
	200025	Rx in lock
	200045	All channels in lock
	200136	Rx out of lock
	200206	Rx in lock pseudo two-way
	200209	All channels in lock
	200340	
	200741	
	203500	All channels out of lock
	203520	Rx out of lock
	203550	Rx back in lock
	203555	Servo in auto
	203705	All channels in lock
	204145	All channels out of lock
	204149	Rx in lock pseudo two-way
	204155	All channels in lock
	205746	An apparent B-2-1 blip was observed

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 30/161844 to 31/073529

SIG STR (dbm)	TIME (GMT)	REMARKS
	211120	AGC varying at TM
	211246	Observed B-20-2
-146	211314	
-130	211325	
-133.5	211334	
-133	211340	
-125	211357	
-125	221811	Steady
-125	225500	Signal level steady
	001900	DSIF 59 lags 51 by 40 micro secs.
	011600	Channel 8 out for a split second
	012400	Not having any TTY circuit; we are unable to transmit out station reports
	005800	Started tape recorder A reel 3; the delay was result of a request from station 51 to look for B-20 blips which occurred, but was not observed at station 59; the blips occurred at 012000 and 012100
	013700	DSIF 51 report all discriminators out of lock, but was not observed at DSIF 59; the times were 013327 and 013408
-129	062900	
-129	063200	
-129	063500	
-129	063800	
-129	064100	
-131	071200	
	072435	B-20 and B-2-1 blip
	072649	B-20 blip
	072751	B-2-1 blip
	072829	B-2-1 blip
	072847	B-20 blip
	073041	All channels out of lock; signal level down to -143 dbm from -129 dbm
	073200	Channel B-20 and B-2 in lock
	073245	B-2-3 blip occurred
	073457	All channels out of lock
	073529	Rx out of lock
		Servo at limits; end of track

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 30/161944 to 30/164200

SIG STR (dbm)	TIME (GMT)	REMARKS
	161944	Rx in lock
	161949	Servo in auto
	162027	Rx out of lock
	162035	Rx in two-way lock
	162057	Discriminators in lock
-89.2	162138	Acquired in main beam
	162205	Decom in sync
	162235	Started TM data
-87.7	162519	
	162550	Digital printer on
-90.7	162622	Signal level dropping
-97.8	162658	
-90.7	162758	
-120	163000	
	163050	Rx out of lock
	163100	Stopped sampling data
-95	163225	Rx in lock one-way
-120	163435	
	163501	Rx searching
-96.4	163528	Rx in lock; two-way
	163557	Discriminators in lock
	163620	Restarted TM data
	163632	Servo at prelimits
	163651	Decom in sync
	163857	Discriminators out of lock for a moment
	164002	Rx out of lock
	164004	Rx in lock
	164029	Rx out of lock
	164034	Rx in lock
	164100	Signal level dropping
	164200	Rx out of lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 30/163353 to 30/235235

SIG STR (dbm)	TIME (GMT)	REMARKS
	163353	Initial acquisition
	163400	Rx in lock
	163600	Tracking data started
	163640	Transfer from 51 to 41
-121	163800	
-122.9	163800	
-112	164000	
	164200	Rx on side band
		Rx in lock
	164318	Tx ON at 164318
	163400	Rx out OFF lock
	164400	Rx in two-way
	164800	All channels in lock on decom
-104.4	164900	
-97	165200	
	165400	TM data looks good
	165700	AGC Rx 97-101
	170000	Rx to 20 cps bandwidth
-103	170500	TM all calibration points check
-103	173300	
-111	173800	
-108.5	174700	
	175100	Standby to go HI-LO mode
-107	175200	
-110	175800	
-112.3	175900	
-113.5		
-114.8	180000	
	180200	Channel 4 on TM out of lock for 30 sec
	180500	WWV time check 38 m/sec
-108	181000	
-112	183000	
-108.7	184000	
	184800	Tx standby to reduce power
-113.5	185200	
	185100	Servo has slight malfunction on readout
	185600	AGC 036
-112.3	185600	
	185700	Start reducing Tx power to 041
	185856	Tx is reducing power by 10 db
	185900	Tx reading 042
	190000	Tx is now 041
-110	190100	R standby to lose lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 30/163353 to 30/235235

SIG STR (dbm)	TIME (GMT)	REMARKS
-109.7	190800	Station 51 is about to come up Tx power
	190900	Rx out of lock for a few moments
	191000	Servo in aided track for a few sec
	191528	TM in HI-LO mode 190957
	192200	Tx is off
-114.8	193000	Two-way and pseudo
	193100	
	193280	
	193800	
	193700	S/C is still in a roll search mode
-113.5	194700	S/C Earth acquisition at 194500
	195100	
	195700	Tape recorder B at 195730
		Station 51 will turn off at 200000; ours will
		come on at 200100
	195900	Rx out of lock for a few seconds
		Tx ON at 200100
		Rx out of lock 200153
	200100	Servo to aided track
	200200	Rx still out of lock
-116		Rx in two-way lock
	200700	Station 41 receiving predictions
	201000	
	201200	Standby for command MSG
	201300	Tx in command mode
-116	201545	Command modulation ON
	201800	Command MSG on RA35
	201900	Command MSG able coming in
	202000	Standby to transmit command RTC-O
	202500	RTC-O initiated 202500
		RTC-O verified 202529
	202600	Stop command transmission from Netcon
	203300	Standby to turn off Tx 2035
		Tx OFF at 203500
		Rx out of lock 203510
-116		Rx in lock 203515
	204000	
	204100	Rx out lock for a few moments
		Servo to aided track
	204200	Rx in pseudo two-way lock
	204900	TM changed to low mode on decom at 204910
	205400	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 30/163353 to 30/235235

SIG STR (dbm)	TIME (GMT)	REMARKS
-117.5	205700 210000 210600	Rx has a false doppler lock; suspected the lock from 2041
-103	211300	
-104	211400	
-101.6	211700	
-101.6	211800	
	211900	Decom is fully in lock
-101.4	213000	
-102.8	220000	WWV checked with clock delay 38 m/secs
-103	222600	
-103	223000	
-103	224000	
-103	225000	
-103	230000	
-103	231000	
-103	232000	
-103	233000	
	231847 233700	
		Last rate 4 sync from TM Servo reports nearly in prelimits Servo in prelimits 233930
-103	234000	Rx switched to acquisition aid
-108.4	234100	
-109.2	234200	
-111		
-113.5		
-114.8	234300	
-119.5		
-120.7		
	234330 234600	
-135.9		
-136.8		Decom dropped lock
-137.6		
-138.5	234700	
-134.3		
-140.9	234800	
-143.2	234800	
-144.6		
-145.3		
-147.3		
-147.9		
	234940	TM ceased transmitting data
-149.1		

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 30/163353 to 30/235235

SIG STR (dbm)	TIME (GMT)	REMARKS
-149.7 -150.7 -153.1 -154.3 -155.0 -157.2	235000 235100 235138 235235	 Tx first out of lock Rx lost lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 30/184325 to 31/073051

SIG STR (dbm)	TIME (GMT)	REMARKS
-134.7	184325 184334	Rx in lock Sampling data; 1 min sample rate Servo in auto; pseudo; two-way
-125.7	184830	
-123.8	184930	Sent station tracking report
	184940	All discriminators in lock
-120.8	185200	
	185250	Transmitting TM data
-117.6	185400	
-115.0	185700	Tracking is smooth
-118.6	190300	
	190857	Tx on
	190900	Discriminators out of lock
	190909	Rx out of lock
	190924	Rx in lock; two-way
	190928	Servo in auto
	190933	Discriminators locked up
-117.6	191300	+0.4 v AGC
	191847	Started transmitting tracking data; 1919 tracking report
-115.5	192547	
-115.3	193150	
-119.7	193358	
-116.5	194015	
	200000	Tx off
	200017	Servo in aided track; Rx out of lock
-114.2	200020	Servo in auto
		Rx in lock; one-way
	200050	Discriminators back in lock
	200156	Rx out of lock; discriminators out of lock
	200244	Discriminators in lock
-115.3	200243	Rx in lock; pseudo two-way
	203505	Rx out of lock
	203606	Tx on
	203618	Rx in two way; 60 cps bandwidth
	203633	Discriminators in lock
	204128	Rx out of lock; servo in aided track
	204150	Rx in two-way confirmed
	204205	Discriminators in lock
	204223	Decom in sync
-115.3	204200	
	205700	+0.250 v AGC
	210400	Received command message RTC-3
	210800	RTC-O initiated

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 30/184325 to 31/073051

SIG STR (dbm)	TIME (GMT)	REMARKS
-107	210839	RTC-O verified
	211000	RTC-O initiated
	211040	RTC-O verified
	211200	RTC-3 initiated
	211239	RTC-3 verified
	211240	B-20 blip
	211310	Rx level down and up to -107 dbm
	214200	Rx momentary signal level drop of -20 db
	220000	Steady
	223140	Momentary loss of lock on discriminators, coinciding with drop in signal level
	223145	Discriminators in lock as signal level returned to -107 dbm
	224830	Rx dropped lock momentarily; discriminators followed in and out of lock
	235726	Tx going up 4 cycles in frequency
	235940	Rx returned to 20 cps bandwidth
	001817	Momentary loss of signal reported by instrumentation
	003240	Momentary blips at instrumentation, all channels
	003854	Repeat of 003240 incident
	004954	Repeat of 003240 incident; sharp spikes on Channel 6
	005907	Spikes on Channel 6
	011000	Repeat of 003240 incident
	011642	Repeat of 003240 incident; Rx momentarily out of lock
	011712	Transients on TM
	012612	Transients on TM twice in succession
	013327	Discriminators out of lock; Rx out of lock
	013543	Discriminators in lock; Rx in lock
	014700	Transients on TM channels
	024300	RA-54 out
	033200	RA-54, RA-30, RA-6 and SCAMA I and II out
	033500	RA-30 in, moving slowly
	034326	Updated TM data 0349; sent tracking report
	040404	Transients on TM channels
	040610	Rx dropped lock, discriminators out of lock
	040718	Rx in lock
	040808	Discriminators in lock
	040900	Decom in sync; good data

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 30/184325 to 31/073051

SIG STR (dbm)	TIME (GMT)	REMARKS
	042341	Decom in sync
	044325	Transients on TM channels
	044700	Rx dropped lock momentarily
	050100	Transient on TM channels
	051200	Rx dropped lock momentarily
	052000	RA-30 out
	052900	CEC recorder tripped out; non-operational, apparently due to overheating; taken out of operation
	060100	Transponder static phase error zeroed out
	060304	Discriminators out of lock
	060400	Discriminators in lock; decom in sync
	060900	Tx reducing power
	061031	Interrupted TM data; tape loop
	061000	RA-30 out
	061800	Lock transfer procedure in process
	063000	Tx off; Rx out of lock
	063014	Servo in aided track
	063030	Pseudo two-way lock; auto
	063050	Discriminators in lock
-111.2	063200	
-111.2	063500	
-111.2	063800	
	072000	Signal level dropping fast
	072200	Antenna at horizon
	072300	RA54 & RA30 in
	072721	B-20 blips
	073051	Rx out of lock; end of pass 2

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/053121 to 31/170650

SIG STR (dbm)	TIME (GMT)	REMARKS
-139	053121	Rx in lock
	053100	Data on
-136	053218	
-120	053329	Increasing
	053500	Servo in slave
	053527	RCA receiving Channel 8 approx 5 min
	053737	B-19 discriminator replaced
-112	054546	
	054500	Tracking data to lab
	060403	RCA reports signal level on Channel 8 is low - checking to see what can be done to raise it; TM data is reducible but would like higher level; will accept as is for now
	062234	Tx on; 200 w; VCO 29668349 Mc; Rx in two-way
	063420	N/C requested signal levels for 0632; 0635; and 0638; at 0632 level was -112.0 dbm; for 0635 level is -112.0 dbm
-112.0	063200	
-112.0	063500	
-112.0	063800	
-112.13	065230	Steady
-111.4	070420	
-112.3	070545	AGC
	071000	Tx turned on
	072000	1-RTC-0 initiated
	072039	1-RTC-0 verified
	072200	2-RTC-0 initiated
	072239	2-RTC-0 verified
	072400	SC-1 initiated
	072439	SC-1 verified
	072441	SC-1 event (B-20)
	072446	B-2-1 event
	072600	SC-2 initiated; read in correct; now being transmitted; 35-0372-0
	072639	SC-2 verified
	072640	SC-2 event (B-20)
	072800	SC-3 initiated
	072839	SC-3 verified
	072842	B-20 event
	073845	Net Control advises a possibility of losing lock during midcourse, but it is expected; reacquiring should occur rapidly; report reacquiring two-way lock to JPL when it is established

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/053121 to 31/170650

SIG STR (dbm)	TIME (GMT)	REMARKS
-113.0	075252	Battle-short sw initiated
	081500	
-111.4	081925	RTC-3 initiated RTC-3 verified
	082000	
	082039	RTC-4 initiated midcourse - 26 RTC-4 verified
-125.8	082356	
	083000	B-20 event B-2-1 event
	083039	
	083040	B-2-1 event Holding steady
	083045	
-126.8	083145	SFOF reports S/C roll was good TM out of lock
	083541	
	083645	TM back in lock; apparently no loss of data Holding steady
	084359	
	084412	
-128	085229	
-139	090138	S/C has acquired both earth and sun lock (Net Control)
-140		
-124	091021	Rx reports noise on panalyzor; may be ignition
	093135	
	093835	RTC-0 initiated RTC-0 verified
	094000	
	094039	2-RTC-0 initiated 2-RTC-0 verified
	094200	
	094239	RTC-3 initiated RTC-3 verified
	094400	
	094439	B-20 event Signal level -110.5 dbm holding steady mid- course sequence completed, S/C maneuver good
	094440	
	094622	Signal level on normalized curve Command modulation off
-110.6	094839	
	095016	Rx in bad data; changing frequency Went to synthesizer
	100000	
	100050	Rx in good data
	100056	
-111.6	100400	
-112	101010	
-112.2	101800	
-112.1	102500	
	103000	Decom in low mode
-112.6	104500	

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/053121 to 31/170650

SIG STR (dbm)	TIME (GMT)	REMARKS
-112.4	110402	
-112.8	111648	
-113.0	113626	
	115501	Momentary noise appeared on Rx panalyzor
-113.2	120000	
	120100	4th digit from right on Rx counter is occasionally wrong
-113.3	122043	
-113.4	122756	
-113.4	123430	
-113.5	123830	
-113.7	125936	
	132340	Bad commands for servo; in aided
	132520	All rates in sync
	133000	Rx good/bad data sw to bad
	133015	Servo in slave
	133100	Tx on synthesizer; Rx good/bad data sw to good
	133130	Rx reports 3 volts static phase error
	133300	AGC signal level -113.9 dbm
	134000	Rx to bad data; Tx off synthesizer
	134103	Tx on synthesizer
	134105	Rx to good data
-114.1	134500	
	135000	Rx getting noise on panalyzor
-114.3	135258	
-114.4	140750	
-114.7	142502	
-114.77	143800	
-114.7	144100	Test offsets inserted
-114.68	144400	Test offsets inserted
	150748	Rx reports noise appearing on panalyzor
-114.9	151520	
-115.0	152000	
-115.2	153100	
-115.5	155137	
	155651	Rx in 60 cycles bandwidth
-115.8	160000	Tx power being lowered
	160015	Tx power was 20 w
	160150	S/C AGC 041
	160223	Rx out of lock; RCA out of lock; Tx out of lock
	160227	Rx in pseudo noncoherent two-way lock; Tx turned off
	160245	TM back in lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/053121 to 31/170650

SIG STR (dbm)	TIME (GMT)	REMARKS
	160350	TM decom in lock; Mode 3 appearing
	160500	TM back in Mode 3
-115.8	160828	
	160900	Rx in 20 cycle bandwidth
-116.0	163300	
-116.1	164935	
	165436	Rx reports signal level varying
-115.9	165640	Signal level increased
-116.0	165800	
-116.2	165935	Signal level decreasing - antenna in brake; end of movement
-116.4	170129	
-117.0	170225	Signal level dropping
-132	170254	
-135	170301	
-137	170334	
-140	170354	
-145	170420	
	170439	TM out of lock
	170500	Tape recorders off
-150	170515	
-152	170532	
-155	170549	
-157	170617	
-160	170634	
-162	170645	
-164	170650	Rx out of lock; TM off
	170602	Data off

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 31/201220 to 01/075104

SIG STR (dbm)	TIME (GMT)	REMARKS
-135	201220	Rx in lock
	201600	
	201625	Digital printer on
-118.5	201800	Servo in auto
	201930	
	202000	No sign of TV Transmission
-117	203400	
-116	203700	
-116	204500	
	210100	Instrumentation reports bad tones
	210200	Rx out of lock
	210200	Discriminators out
	210300	Rx in lock
	210330	Tx power on
	210500	Two-way lock; AGC 032
	210525	Discriminators in lock
	210610	
	213600	Data transmitting tracking data
	215200	
-116	223130	Signed level dropped seriously
-133	231600	Drops in AGC voltage noticed; 1 or 2 db changes for a few sec
-115.8	232000	Another signal level drop noticed
	232235	Signal drop of about 2 db noticed
	235401	Rx out of lock
	235500	Rx in lock
	002259	Rx reports spurious blips
	003830	Rx out of lock; discriminators out of lock
	003859	Servo to aided track
	003900	Rx in lock
	003940	Discriminators in lock
	004018	Rx out of lock
-116.5	004025	Rx in lock
	004048	Servo in auto
	004242	Rx out of lock; servo in aided track
	004258	Rx in lock
	004300	Discriminators in lock
	004800	Suspected out of two-way lock
	004852	Rx tripped out
	004900	Tx on
	004930	Rx out of lock
	004942	Rx in lock; two-way
	005216	Rx in lock; two-way

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 31/201220 to 01/075104

SIG STR (dbm)	TIME (GMT)	REMARKS
-116.6	005248	Discriminators in lock
	012844	Rx in and out of lock momentarily
	014410	B-19 discriminator out of lock; lost rates 3 and 4 on decom
	014447	Discriminators in lock
	015000	Rx out of lock to reacquire
	015104	Rx in lock
	015153	Discriminators in lock
	020526	Rx out of lock momentarily
	020702	Discriminators in lock
	022000	Small spike B-20 which could be a pulse
	023730	Stopped sending TM data
	024343	Restarted TM data
	025845	Rx out of lock
	025857	Rx in lock
	025910	Discriminators in lock
	032159	Rx out of lock briefly
	032323	Discriminators in lock; decom out of sync
	034000	Reset sync on decom
	040800	RA-6 out
	041700	RA-6 in
	042800	
	055400	Tx zeroing out static phase error preparatory to transfer procedure
	060100	Rx out of lock
	060125	Rx in lock
	060146	Discriminators in lock
	060200	RA-6 out
	060700	Tx at low level
	061500	RA-6 in
	061951	Tx off
	062022	Rx out of lock
	062026	Rx in lock; pseudo two-way
-116.6	063900	
-116.6	064200	
-116.6	064500	
	072200	TM restarted after interruption due to wrong Faccon patch
-121	074200	Signal level dropping
	074500	Channel 6 discriminator losing lock
	074615	Channel 8 discriminator losing lock
-136	074646	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 31/201220 to 01/075104

SIG STR (dbm)	TIME (GMT)	REMARKS
-144	074800	All discriminators going out of lock; stopped digital printer
	074827	
	074910	Decom out of sync
	075000	Servo to aided track; all TM out of lock
	075104	Rx out of lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 01/053740 to 01/172550

SIG STR (dbm)	TIME (GMT)	REMARKS
-140	053740	Signal acquisition; RF lock
	053810	Data on 1 sec sample rate
	053815	TM in lock
	053950	TM started transmitting data
	054156	Servo in aided track; following predicts
-118	054300	Rx signal level on normalized curve
	054510	Servo in slave
-116.5	054600	
-115.7	055200	
	055300	Data being sent to JPL
-116.5	060100	
-115.6	060200	
	060228	In lock; decom in sync; data
	060439	Tx on - RF lock
	060526	10 cycle on - 5 sec - two-way lock
-115.2	061125	Rx to 20 cycle bandwidth
-115.8	062035	Normalized curve
	062400	RCA reports channel 8 TM looks good
	062000	Rx reset offset of db converter; corrected dbm -115.8
	063300	
-115.8	063900	AGC signal level; normalized curve
-115.8	064200	AGC signal level; normalized curve
-115.8	064500	AGC signal level; normalized curve
-115.17	071000	AGC signal level; normalized curve
-115.4	074700	Signal level; normalized curve
	080400	Considerable noise on Rx panalyzor
-115.65	084800	
-115.8	091716	
-116.3	095153	
-116.4	100940	
-116.6	102014	
-116.7	103303	
-116.4	105930	
-116.7	112857	
-116.3	122001	
	123430	CEC recorder off for paper change
	124010	CEC started after paper change
-116.9	133835	
-117.2	142416	
-117.5	145000	
-117.35	150200	
-117.35	150800	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 01/053740 to 01/172550

SIG STR (dbm)	TIME (GMT)	REMARKS
	152730	Considerable background noise - coming and going - Rx panalyzor
-117.9	155945	
	162022	RCA received a clock pulse event
-118.0	162732	
-118.5	164356	
-118.0	170501	
-118.2	170620	Tx synthesizer dropped lock momentarily
-118.3	171120	
-118.5	171240	
-118.0	171530	
-118.4	171900	
-118.5	172090	
-122.5	172228	
-125.0	172309	
-126.0	172315	
-128.0	172339	
-129.0	172340	
-130.0	172355	
-131.0	172415	
-132.0	172424	
-133.0	172433	
-134.0	172437	
-137.0	172455	
-139.0	172504	
-140.0	172508	
-141.0	172525	
-145.0	172536	
	172550	Rx out of lock - attempted pseudo two-way; unable to acquire

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 01/060845 to 01/172726

SIG STR (dbm)	TIME (GMT)	REMARKS
-148	060845	Rx in lock TM recorders and data ON
	060859	
	061018	
	061054	
-143	061056	Rx in good data
-140	061130	
	061153	
	061158	
	061202	Data indication that synthesizer is in lock
-137	061215	
-135	061300	
-133	061345	
-132	061412	Servo system in slave
-130	061450	
	061530	
-128	061540	
-127	061555	
-125	061620	
-123	061640	
-121	061715	
-120	061750	
-119	061830	
-118	061905	
-117	061955	
-116	062030	
-116.8	062115	
-116.5	063000	
-116.5	063900	
-116.7	064200	Started optimizing antenna position
-116.7	064500	
-116.7	065230	
-116.7	065610	
-117	070000	Stopped optimizing antenna position
-117	071500	
-117	073000	
-117.5	073700	
-117.25	074500	AGC; teletype reperferator failed
-117.4	080000	
	081600	
-117.2	090000	
-117.2	091930	Reperferator back in operation (repaired) AGC -0.74
-117.3	093000	
-117.3	094500	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 11

VIEW PERIOD: 01/060845 to 01/172726

SIG STR (dbm)	TIME (GMT)	REMARKS
-117.2	100000	
-117.2	102435	
-117.1	103130	
-117.2	104500	
-117.1	113000	
-117.1	120000	
-117.1	122900	
	123400	Teletype distributor caused bad data sample
-117.0	130000	-0.76 AGC
	132444	Started optimizing antenna position
-117.0	132702	Optimizing stopped; no change
-117.0	132950	
-117.2	135320	
-117.2	140000	
-117.0	141500	
-116.9	142455	
-117.1	150000	
-117.4	150200	
-117.4	150800	
-117.4	151816	Started optimizing
	152040	Stopped optimizing; no signal change -117.4
-117.3	153000	
-117.0	154900	
-116.9	160000	
	161501	Bad servo commands
	161540	Aided servo track
	161731	Servo in slave
-116.7	161810	
-116.7	1630	
	163069	Momentary bad commands
-116.6	163710	
-116.4	165300	
-116.6	170000	
	170039	CEC recorder off because of malfunction
-117.0	170600	
-117.1	171345	
	171500	Rx in bad data; bad servo commands
	171510	In aided track
	171615	Servo in slave
-117.2	171735	
-117.4	171752	
-118.2	171900	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 01/060845 to 01/172726

SIG STR (dbm)	TIME (GMT)	REMARKS
	172000	Rx in good data and synthesizer in lock
-117.4	172030	
-118.6	172100	
-117.9	172130	
-127	172250	
-130	172340	
-132	172400	
-134	172410	
-136	172420	
	172440	
	172459	Channel 2 and 6 out of lock
	172521	Channel 3 out of lock
	172521	Channel 3 back in lock
	172704	Channel 3 out of lock
	172726	Rx out of lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 01/124610 to 02/003820

SIG STR (dbm)	TIME (GMT)	REMARKS
-116.0	124610	Rx in lock
	124700	
	124800	Servo in auto
-121.5	124900	All rates in sync
-119.0	125000	
-119	125100	
-122	125200	
-118.5	130700	
-117.7	135500	
-117.7	150200	
-117.7	150500	
-117.7	150800	
	171800	Rx in 60-cycle bandwidth
		Rx in two-way
	171900	Rx out of lock momentarily
	172545	Tx ON
	172608	Mod ON and in two-way lock
	172910	Rx out of lock momentarily
	172940	Rx in good two-way lock
	210000	Tx VCO drift reported to Able as being 4-8°/s in the last hour
	215300	Rx out of lock momentarily
	215300	Servo in aided track for a few sec
	230200	Rx AGC readings taken at 2212, 2215, 2218, and were all -117.8 dbm
	234100	Rx out of lock for a few sec
	234300	Tx on 041
	234500	Rx out of lock for a few sec
	234600	Tx OFF
		Rx to pseudo two-way
	234800	S/C static ϕ error 051
	235200	Doppler data to good and in pseudo two-way
-119.6	000000	
-119.6	000300	
-119.6	000600	
-123	002200	
-120.6	002600	
-125	003100	
-127	003200	Steady at that now
-140	003400	
-147	003500	
	003500	Decom out of lock for about 30 sec

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 01/124610 to 02/003820

SIG STR (dbm)	TIME (GMT)	REMARKS
-150	003630	Decom out of lock
	003700	
	003820	Rx out of lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 01/202723 to 02/075337

SIG STR (dbm)	TIME (GMT)	REMARKS
-115	202723	Rx in lock
	202700	Data sampling
	202800	All discriminators in lock
	202838	Started punching data
	202725	Servo in auto
	203600	All TTY circuits out; power failure at the Tx of Olifantsfontein
	204300	Resumed transmission of tracking data
		RA-54 in
	204953	Turned instrumentation digital printer ON
	205000	Tracking data transmitted
	205230	All rates in sync
	205500	All TTY circuits out due to Olifantsfontein power failure
	205700	RA-54 back in circuit
	210254	Tracking data transmitted
	210530	Data stopped transmission of tracking data
	210640	Telemetry transmission
	211004	Telemetry stopped transmission so that carrier frequency could be transmitted; RA-54 only circuit available
	211500	Telemetry tones patched in on RA-54
	213128	RA-30 in
	213500	Rec momentarily out of lock
	213616	Rec momentarily out of lock; at the times when Rx lost lock; the doppler frequency changed 3437 - 3417 = 20 cps
	214100	Tracking data resumed transmission
	214230	Rx momentarily out of lock; doppler frequency now down to 3407
	220500	Turned paramp off; VCO went up 6 cycles
	224340	Channel 3 discriminator dropped; lock was locked to sideband
	224640	Tele stopped transmission of tele data
	224700	Data tracking data transmission resumed
	231414	Very short loss of discriminators lock ± 10 msec
	232700	Rx to 60 cps bandwidth
	232830	Paramp switched on
	234110	Rx and discriminators out of lock
	234157	Rx and discriminators in lock
	234327	Rx to bad data
	234520	Tx ON
	234543	Disc out of lock

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 01/202723 to 02/075337

SIG STR (dbm)	TIME (GMT)	REMARKS
-115	234600	Disc in lock; Rx in lock
	234626	Rx out of lock
	234630	Two-way lock; all loops in lock
	001900	Restarted transmission of tracking data
	003900	Tx OFF
	003909	Rx out of lock
	003910	Discriminators out of lock; changing Tx VCO
	003920	Rx in lock; one-way
	004012	Tx ON
	004017	Rx out of lock
	004031	Rx in lock
	004210	Tx sweeping
	004300	Static phase error being zeroed out
	004302	Discriminators in lock
	004309	Confirmed two-way lock
	020000	Stopped TM data
	020605	Resumed sending TM data
	022200	RA-54 out
	030000	Tx OFF as instructed; Rx out of lock
	030016	Rx in lock; one-way
	030200	Transmitting one-way doppler
	031500	Tx ON; Rx out of lock
	031510	Discriminators out of lock
	031512	Rx in lock; discriminators in lock; two-way
	053800	Stopped CEC recorder to adjust paper
	053916	Restarted CEC recorder
	054757	Restarted TM data
	055500	Tx preparing for transfer procedure
	055700	Tx reducing power
	060000	Decom to + hi lo + mode
	060134	Tx OFF
	060157	Rx pseudo two-way
	062300	All telex circuits out; 0630 tracking report
	063107	Stopped digital printer; paper change
	063155	Restarted digital printer
	072500	All TTY circuits in the green
-119	074135	
-121	074151	Falling rapidly
-124	074233	Falling
-128	074303	
-129	074841	

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 01/202723 to 02/075337

SIG STR (dbm)	TIME (GMT)	REMARKS
-131	074907	Aided track
	074919	
-133	075000	
-139	075037	
-141	075154	Discriminators out of lock Rx out of lock
	075200	
	075337	

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 02/053600 to 02/092433.145

SIG STR (dbm)	TIME (GMT)	REMARKS
	053600	Acquisition of signal
	053625	Data to 1 minute
-160.4	053632	In lock; level \pm threshold
	053700	TM started punching data
-143.0	054100	
-125.2	054020	-124.7 on the normalized curve
-120.3	054420	
	054500	Servo in slave
	054640	RCA receiving channel 8 telem
-119.6	054800	
	054946	Rx reports large ignition noise; fading somewhat with occasional spikes
	055100	Tracking data being sent to JPL
	055345	RCA reports that Channel F warmup will start at 090538; impact at 092442; RTC 7 will be transmitted 090902
-118.5	055700	
	055847	Rx switched to two-way; TM dropped sync reacquired
	060025	Tx on - 200 w; two-way lock
	060128	Started changing VCO frequency Tx
	060333	VCO locked to Tx synthesizer
-118.3	061200	
	062000	Rx reports interference on panalyzor
	062100	Rx reports heavy spikes on panalyzor
	062200	Rx reports heavy spikes running 20 db above the signal; cause unknown; may be ignition; no vehicles in sight
-118.2	062600	Signal level -118.4 dbm on normalized curve
-118.7	065600	
-118.3	070230	Doppler count 3487
	070541	AGC detect voltage 3.55 volts
-118.6	070700	
	071700	AGC monitor signal level -118.5; normalized curve -118.7 dbm
	072200	Rx checked all meters; system looks good
-118.6	073400	
	074500	Station Director reports all systems green
-118.7	075700	On normalized curve
	080000	Station Director announced all vehicular traffic cease
	080104	Tx modulation on
	080312	Noise in Rx panalyzor continuing; looks like ignition

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF -12

VIEW PERIOD: 02/053600 to 02/092433.145

SIG STR (dbm)	TIME (GMT)	REMARKS
-118.7	080546	Rx reports continued noise which appears to be ignition noise
	080725	Maser reports ignition noise on panalyzor
	081000	1-RTC-0 initiated
	081039	1-RTC-0 verified
	081200	2-RTC-0 initiated
	081239	2-RTC-0 verified
	081400	Tx modulation off
	081700	Rx to good data sw
	082041	RCA TV clock pulse event advanced 1 step
	082300	
-118.5	082442	1 per sec sample rate - data
	082659	RCA bandwidth checks started
	083610	Rx reports noise spikes 20 - 30 db above signal; cause unknown
	083955	Tx to battle short position
	084010	Maser and Rx report increasing noise spikes on panalyzor
	084500	Tx modulation on
	084600	
	084635	Station director reports all signals green
	084729	Maser reports noise increasing; Rx reports noise 20 - 30 db above signal
	084858	Maser reports paramp steady, no change in past hour
-118.3	085625	Servo in aided track; computer lost
	085809	Servo in slave; computer in; loss cause unknown
	090057	Rx reports noise spikes decreasing in intensity; occasional spikes
	090140	
-118.3	090400	
	090442	Data sample rate 1 per 10 sec and 1 per min - 1 per 10 sec sent to lab
-118.4	090600	
	090800	RTC-7 initiated
	090839	RTC-7 verified
	090842	B-20 event
-118.3	091130	
	091245	RCA reports some indication of a drop indicating warmup - no video
-118.3	091410	
-118.3	091500	

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 02/053600 to 02/092433.145

SIG STR (dbm)	TIME (GMT)	REMARKS
	091529	RTC-7 initiated
	091608	RTC-7 verified
	091611	B-20 event
	091921	RTC-7 initiated
	092000	RTC-7 verified
	092003	B-20 event
	092433	Loss of signal; out of lock; ant coords dec 001402, HA 326644 at impact

TABLE A-1
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 02/061055 to 02/092433

SIG STR (dbm)	TIME (GMT)	REMARKS
-153.5	061055	Signal acquired
	061110	TM and data on
-147	061200	
	061206	Channel 3 lock
	061223	Rx good data
	061244	Channel 2 lock
-143	061248	
-140	061320	
	061345	Channel 6 lock
-136	061358	
-135	061430	
-132	061515	
-130	061550	
-127	061640	
	061700	Servo in slave and in good data
-125	061740	
-121	061910	
-119.7	062000	
-119	062110	
-118.5	062240	AGC -0.65
	062500	Momentary bad commands
	062630	Microwave to echo good
-118.5	062800	
-118.6	063000	Data reports doppler = predicts
-118.6	063500	
-118.6	064000	
-118.6	064500	
-118.6	065000	
-118.6	065500	
-118.7	070000	
-118.6	070500	Doppler = predicts
-118.6	071000	
	071002	Momentary bad commands
-118.6	071500	
-118.6	072000	
-118.6	072500	
-118.6	073000	
-118.6	073500	
-118.7	074000	
	074010	TTY line 2 garbled momentarily
-118.6	074500	
-118.6	075000	
-118	075500	

TABLE A-I
RANGER VI TRACKING OPERATIONS SUMMARY

STATION : DSIF-11

VIEW PERIOD: 02/061055 to 02/092433

SIG STR (dbm)	TIME (GMT)	REMARKS
	075907	Rx in bad data
	075908	Synthesizer off
	080753	Rx in good data
	081458	Rx in bad data
	081459	Rx in good data
-118.5	082000	
-118.5	082500	
-118.5	083000	
	083230	Bad data on Rx
-118.5	083530	
	083942	Data samples at 1 per sec on punch 2
	084401	Bad data Rx when echo went to VCO
-118.5	084500	
-118.5	085000	
	085059	Rx in good data
-118.5	085500	
	085619	In aided track; bad commands
	085810	In slave
	085910	In aided track
-118.5	090000	
	090010	In slave
-118.5	090510	
-118.5	091100	
-118.5	091700	
-118.5	092030	
	092300	Sanborn to high speed
-118.5	098240	
	092433	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 71

VIEW PERIOD: 28/121700 to 28/165700

SIG STR (dbm)	TIME (GMT)	REMARKS
-69	121300	One-way lock with S/C prior to liftoff - Aux. Osc. at 960.037473 Mc
	121700	Two-way lock acquired
	140600	Measured Aux. Osc. 890 at zero SPE v, 960 at zero SPE, Case 2 temp. for T-90 report
	154000	T-35 Report: "O" SPE = 890.043600 = 960.047029 Temp. Case 2 = 79°F at 1533; NO signal voltage = +0.007 v 55 = 101. 46 = 036
	154700	High Power Mode (39.5 db) was questioned by Track Chief; still in question L - 20 min set VCO (Tx) to 29668.594 Mc for a doppler offset of 494 cycles from zero SPE of 29668.100; report from Track Chief on rise of static phase error as expected
	L-5*	Systems Manager gave an OK for high Power mode in launch
	165000	Launch in two-way lock - 890 signal at S/C is \approx -63 dbm
	165039	Lost lock on Rx
	165235	Regained lock on RF in two-way lock - signal level at \approx -120 to -130 dbm; apparently locked to a sideband
	165749	Lock lost; Track over
		*Launch minus 5 min

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 28/172138 to 28/173255

SIG STR (dbm)	TIME (GMT)	REMARKS
	172138	Rx in lock
	172153	Auto track
	172156	In main beam
	172220	Rx out of lock
	172223	Rx in lock
	172223	Rx out of lock momentarily
	172224	Rx out of lock momentarily
	172225	Rx out of lock
	172228	Rx in lock
	172228	Rx out of lock momentarily
	172244	Rx in lock
	172245	Rx out of lock
	172247	Rx in lock
	172248	Rx out of lock
	172253	Rx in lock
	172254	Rx out of lock
	172255	Rx in lock
	172256	Rx out of lock
	172257	Rx in lock
	172258	Rx out of lock
	172300	Rx in lock
	172301	Rx out of lock
	172302	Rx in lock
	172307	Rx out of lock
	172309	Rx in lock momentarily
	172310	Rx in lock momentarily
	172311	Rx in lock momentarily
	172312	Rx in lock momentarily
	172313	
	172314	Rx out of lock
	172315	Rx in lock momentarily
	172316	Rx in lock
	172317	
	172319	Rx in lock momentarily
	172320	Rx in lock momentarily
	172340	Rx in lock
	172411	Rx out of lock
	172416	Rx in lock
	172555	Rx out of lock
	172603	Rx in lock
	172606	Rx out of lock
	172624	Rx in lock
	172724	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 28/172138 to 28/173255

SIG STR (dbm)	TIME (GMT)	REMARKS
	172759	Rx in lock
	172819	Rx out of lock
	172830	Rx in lock
	172917	Rx out of lock
	172919	Rx in lock
	172922	Rx out of lock
	172932	Rx in lock
	172938	Rx out of lock
	172943	Rx in lock
	172945	Rx out of lock
	172949	Rx in lock momentarily
	172951	Rx in lock momentarily
	172955	Rx in lock
	173009	Rx out of lock
	173014	Rx in lock momentarily
	173151	Rx in lock
	173153	Rx out of lock
	173151	Rx in lock
	173158	End of track
	172356	Auto on ACQ Aid
	172450	Servo to main beam
	172531	-85
	172807	Tx on
	173014	Two-way lock suspected
	173100	Rx to 60 cps bandwidth
	173142	Servo at prelimits
	173207	Signal falling
	173210	51 tones on Scama circuit
	173238	59 tones on Scama and Decom
	173257	Punching 59 data
	173430	Started Rx Channel 8 readout
	173511	Tracking data stopped sampling
	173800	Stn 59 lost lock
	173900	Tx off

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 28/172050 to 28/173753

SIG STR (dbm)	TIME (GMT)	REMARKS
-122	172050	First RF lock; two-way verified
	172100	Servo in auto
	172117	VCO frequency 7253 cps
	172139	Servo in manual
	172140	No TV
	172200	Tracking data going out
	172224	All channels in lock
	172312	Radio out of lock
	172427	Rx in one-way lock
	172506	Servo in auto
	172550	Rx out of lock
	172552	Servo in aided
	172731	No signal seen on screen
	172806	One way lock
	172817	Out of lock
	172829	One way lock
	173000	Servo still in aided
	173020	Rx out of lock
	173114	Tx off; doppler reference to pseudo
	173144	All channels out of lock
	173236	In one way lock
	173236	Servo in auto
	173305	Rx changed to 20-cps bandwidth
	173420	Rx out of lock; servo in manual
	173430	Rx in lock; one way
	173430	Servo in auto
-117 to -119	173530	
	173527	All channels in lock
	173753	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 28/173520 to 29/011700

SIG STR (dbm)	TIME (GMT)	REMARKS
-99.1	173520	Rx in lock one-way
	173600	Servo to auto
	173710	In main beam
	173730	Tx ON
	173800	In two-way lock
	173800	Tx go to full power
	173900	
	173900	Doppler no good from 41
	174000	Decom all rated in sync
	174100	S/C AGC -90 dbm
-103.5		S/C AGC -70 dbm
	174200	TM rate 1 out of sync
	174800	Rx in and out of lock momentarily
-102	175500	
	175600	S/C AGC -72 dbm
-106.4	180200	
	180600	Tx and Rx can expect to remain tracking for next 2-1/2 hr
	180700	
	181000	TM reports occasional spikes on Channel 2
-126	182100	TM reports Channel 2 readout over limits
	182400	TM Channel 2 now OK; appeared calibration error
	183000	
	183300	This is due to S/C antenna null
-107.8	184800	
-111.8	185300	
	185400	
	185900	S/C trajectory report is good
	190350	TM observes loss of rate of sync momentarily
-112.5	191200	Servo report HA are 0.1° low and VEC 1.0° low
	191600	Rx doppler frequencies are correct
	191900	decreasing
	191639	
	192100	TM digital printer has stopped due to fault
	192400	TM digital printer repaired temporarily
-109	192500	
	192800	
	194800	Rx reports doppler is on predicts
	201300	Predicts for servo came through but not logged (only tentative)

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 41

VIEW PERIOD: 28/175320 to 29/011700

SIG STR (dbm)	TIME (GMT)	REMARKS
-115.7	202300	TM reports Earth brightness has increased
	203700	S/C still rolling
	204100	
	210000	Data have received command message and code word is correct
	210600	Command load RTC-0
	210900	Tx static phase error is now zero
	211000	Tx modulation is now on
	211000	Tx S/C -98 dbm
	211100	Command message level of modulation decreased
	211100	Tx S/C -94 dbm
	211500	Command message ready to send on schedule
	211500	RTC-0 initiated
	211538	RTC-0 verified
	211600	RTC-0 initiated
	211638	RTC-0 verified
	211900	RTC-3 initiated
	211939	RTC-2 verified
-103.5	211938	B20 event
	212100	Rx signal strength now coming up; it was -114 dbm
	212200	
	212200	Tx S/C -93 dbm
	212410	Tx to turn off modulation now
	212500	Tx S/C -94 dbm
	212710	System operating OK
	213100	TM reports spikes on Channel 8
-111	213600	Standby to hand over station
	213700	Tx 073 cps
	213900	Rx doppler data to bad
	214000	Rx zero static phase error
	214100	Rx doppler data to good
		Tx at 2150 start reducing power
		Station 41 ready to hand over
		Reduce Tx power until 120 dbm
	214600	Loss circuit RA-56 to Johannesburg
	214900	Tx start reducing power
	215100	Station hand over
	215416	Tx off
	215120	Hand over complete
	215400	Rx back to 20 cps bandwidth

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 28/173520 to 29/011700

SIG STR (dbm)	TIME (GMT)	REMARKS
	215105	10 cps modulation observed on dynamic phase error
	215400	Rx not in pseudo two-way; Rx to 60 cps bandwidth
	215500	Rx now back in pseudo two-way lock
	215700	Rx out of lock momentarily
	220800	RA-56 back at 2205
	215159	10 cps modulation off
	231000	Handing back from 51
	001000	Transfer from 41 to station 51 again
	225400	Tx standby to come on 200 w
	225600	Channel 8 message being received at JPL
	230100	Doppler data to bad 60-cps bandwidth
	230300	51 reducing power on Tx
	230600	Tx now on
	230600	Rx in two-way lock; all loops in lock
	230600	Tx reducing to 200 w level
-105.7	231200	All channels out of sync momentarily
	231700	Station 41 requested to observe since schedule of Tx switching
	231900	001020 transfer will be completed under non-standard conditions
-106.3	233600	
	234200	TM still receiving spikes on channel; transients on dynamic phase error quite large
	234500	Noise spikes on all channels
	234500	Ground signal at Woomera
	235600	
	000100	DSIF 41 ready to proceed with S/C transfer under non-standard conditions
	000500	3 bursts of 3-sec, 10-cps modulation; Tx reducing power; doppler data to bad
	001032	Tx turned off
	001000	Rx locked up on two-way
	001050	10-cps modulation received from DSIF 51
	001500	TM back to S/C 400 cps
	001540	Hand over complete
	001400	All channels lost sync momentarily (3 sec)
	001600	Approximately 8 to 10 data samples will have wrong time caused by clock sampling on the data change

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 28/173520 to 29/011700

SIG STR (dbm)	TIME (GMT)	REMARKS
-106	002000	TM showing spikes on dynamic phase error
	004000	
-108.4	010200	Signal strength dropping rapidly
-114.4	010900	
-120.6	011200	
-124	011300	
-125	011346	
-133.6	011400	All TM out of lock Rx out of lock
-136.4	011500	
	011640	
	011700	

TABLE A-1
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 28/204550 to 29/085429

SIG STR (dbm)	TIME (GMT)	REMARKS
-125	204550	Rx in lock; signal increasing
	204550	Rx in lock; -125 dbm increasing
	204552	Data sampling
	204607	Auto track
	204627	Main beam
-120	204835	Tracking data being transmitted
	204951	51 data being transmitted in place of 59
	205040	Receiving Channel 8 modulation
-117	205125	
	211939	B-20 event blip
	212026	Signal level increasing
-108	212056	
-107	212130	
	213700	Exciter on; VCO frequency adjusted
	213800	Rx to 60-cps bandwidth
	214700	DSIF 41 reducing Tx power
	214900	S/C AGC reducing
	215027	S/C AGC -118 dbm
	215103	Tx on; two-way verified; 200 w
	215155	Tx VCO 29.6684143 S/C AGC -91.5 dbm
	215556	Rx to good data
	215615	TM to S/C position
	220136	Rx to 20-cps bandwidth
	225200	Advised to be prepared for transfer at 2310 back to 41
	225800	Rx to bad data
	230100	Rx to 60-cps bandwidth; TM to decalock
	230200	Transfer proceeding
	230300	Tx reducing power
	230559	Rx dropped lock
	230604	Rx in lock
	230752	Tx off; GM-32 with 41 after 3 sec drop out
	232520	Rx to 20-cps bandwidth
	233600	Stopped TM data; back tracked 5 min
	233800	Restarted TM data
	000500	10 cps modulation appeared
	000600	Exciter on
	000600	Rx to 60 cps
	001000	Tx on; up to 200 w; two-way lock
	001326	Rx to 20 cps
	001427	Rx out of lock and in again
	012240	Step change occurred in point 9
	012500	All TTY circuits out except RA-30
	014200	RA-6 in

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 28/204550 to 29/085429

SIG STR (dbm)	TIME (GMT)	REMARKS
-128	015100	Rates 1 and 2 out of sync
	024850	Decom reading Mode 3 instead of Mode 1
	024958	Decom O. K.
	050500	Stopped TM for FRXD tape change; 050503 decom to +10
	050900	Restarted sending TM
	062000	PT5 of Channel 8 TV Data has fallen from -5.2 v to -5.0 v
	064600	PT5 of Channel 8 shows a further degradation to -4.9 v
	070000	Station tracking report; Tx keying to 10-cps modulation
	070100	60-cps bandwidth
	070300	Tx reducing power; 070742 Rx out of lock modulation
	070800	Tx off. GM-32
	070835	Rx to good data
	071400	Rx to 20-cps bandwidth
	080000	Station tracking report
	083200	Point 5 of Channel 8 shows further degradation to -4.8 v
	084100	CEC recorder stopped; take-up spool fault
	084700	Signal dropping; servo at horizon
	084817	Restarted CEC recorder
	084922	Antenna on horizon
	085104	Dropping
	085429	Rx out of lock; S/C below horizon

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 28/201143 to 29/085236

SIG STR (dbm)	TIME (GMT)	REMARKS
-135	201143	Rx in lock, VCO Tx 8212
	201300	Below horizon
	201410	Servo in auto
	201420	All telemetry channels in lock
-135	201436	
	201529	Data sampling
-137	201710	
	202000	B21 blip
-134	202100	Steady
	202100	All telemetry channels in lock
	202700	Telemetry very good
-131	202730	
	205448	Now receiving 030 predictions
	210517	Rx out of lock
	210517	Servo to man
	210517	All telemetry channels out of lock
	210534	Rx back in lock
	210534	Servo in auto
	210539	Rx out of lock
	210558	Rx in lock
	210700	Servo in auto
	210811	Broken galvo B19 channel MI recorder
	210900	All telemetry channels in lock
	211246	Galvo repaired B19 channel OK again
	211600	Spike on B20 channel
	211939	B20
	212015	Rx out of lock
	212015	Telemetry channels out of lock
-127	212017	Rx in lock
	212017	All telemetry channels in lock
-125	212121	
	215100	Executed transfer from 41 to 51 (no loss of lock)
	224345	Investigating doppler mixer in radio section
	224540	Rx AGC -1.12 v -125 dbm
	230600	Rx out of lock; change over from 51 to 41
	230601	Servo to manual
	230620	Rx in lock
	230630	Servo in auto
	233700	No. 1 sample rate selector failed
	233900	Switched in No. 2 sample rate selector
	001000	Handover from 41 to 51 successful; no loss of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 59

VIEW PERIOD: 28/201143 to 29/085236

SIG STR (dbm)	TIME (GMT)	REMARKS
-140	001029	Started to receive 040 predictions; advised they must be used
	003600	Punch trouble; lost one sample
	034400	Sent tracking report (0330)
	050400	Sent tracking report (0500)
	061500	Sent tracking report (0600)
	070745	Rx out of lock; changeover from 51 to 12
	070745	Servo in manual
	070800	Rx in lock
	070800	Servo in auto
	074800	Sent tracking report (0700)
	085100	
	085218	Servo to manual
	085236	Rx out of lock; end of 1st pass

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
	063415	S/C acquired; Rx in lock
	063430	TM tapes started
	064619	Rates 1 and 2 in sync
	064630	TM data to JPL
	064733	Rx signal level varying from -130 to -135 dbm; still on horizon
-129.5	064855	Rx signal level increasing
-122	064927	
-117	065035	
-112.1	065151	
-111	065205	
	065213	Antenna in slave
-112	065357	Rx signal level holding steady between -111 and -113 dbm
	070500	Rx in 60-cps bandwidth
	070520	Rx in lock; data sw in bad data two-way
	070730	Tx on 200 w
	070745	10-cps modulation on
-112	070759	Confirm two-way lock with 10 cps
	070916	Tx on synthesizer; zeroing static phase error
	070933	Rx in good data; 20-cps bandwidth
	071657	Servo Rx optimizing
	072404	Servo offset +0.099 on Dec
-112	073200	
	073435	TM in lock
-112	075123	S/C AGC -1.66 v; S/C equidistant to 51 and 12
-112	075957	
	081318	Command message; Acme being received
-111.7	081500	
	083600	Rx in bad data; Tx off synthesizer
	083617	Rx in good data; data reads Tx synthesizer out of lock
	083800	Command Modulation on, index of 1.2
	083919	Lost modulation
	083943	Modulation on again

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
-111.8	084220	Rx signal level steady with the AGC curve
	085000	1st RTC-O initiated; start of midcourse sequence
	085039	1st RTC-O completed
	085200	2nd RTC-O initiated
	085239	2nd RTC-O completed
	085400	SC-1 initiated
	085440	SC-1 completed
	085441	SC-1 (B-20) event
	085460	B-2-1 event
	085600	SC-2 initiated
	085641	SC-2 completed
	085642	SC-2 event (B-20)
	085800	SC-3 initiated
	085841	SC-3 completed
-111.8	085842	SC-3 (B-20) event
	090000	AGC -1.68 v
	090905	SFOF changes coming in via TTY
-111.6	090908	Station will remain on Tx VCO, with command modulation on until after the midcourse maneuver; instructions via Track 2
	091617	Tx VCO 29668300.5 Mc
	092142	Command Message coming in on TTY
-111.5	092355	RCA reports the 16 hour clock step advanced at 092246; TM reports recording it at same time
	093155	
	093600	RTC-O initiated; start of midcourse maneuver
	093638	RTC-O completed
	093800	RTC-O(2) initiated
	093839	RTC-O(2) completed
	093900	Rx suspending all frequency checks during midcourse maneuver
	094000	RTC-3 initiated
	094039	RTC-3 completed
	094041	B20 event
-125.9 -126	094100	Rx signal level changed from -111.5 dbm to -135 dbm at 094130
	094333	Holding steady after antenna change
	094621	
	094622	Command message coming in on TTY (cleft)

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
	094802	Command message DICE coming in on TTY
	100000	RTC-4 initiated; start of midcourse maneuver
	100038	RTC-4 completed
	100040	B-20 event
	100038	Data to one sec/sample rate; one per 10 sec/sample to lab
	100045	B-2-1 event
	100110	B-2-1 event
-124	100150	
-126	100318	Slowly decreasing
-126.3	100348	Rx signal level steady
	100440	S/C AGC returned to normal
-126.4	100601	Rx signal level steady
-126.7	100637	
-126.2	100813	Rx signal level holding steady
	101010	B-2-1 event
-127.3	101150	
-129	101306	
-131	101325	
-130	101440	
-131	101505	
-132	101510	
-134	101516	
-141	101559	
-150	101640	
	101642	B-2-1 event; Channel 8 TM off
-140	102159	
	102228	No change in doppler
-141.4	102530	Rx Signal level holding steady
-142	102702	
	102720	Doppler changing rapidly
	102709	B-2-1 event
	102713	B-2-2 event
	102716	B-2-3 event
	102828	Doppler change slowed down
	102759	B-2-1 event
	102803	B-2-2 event
	102806	B-2-3 event
-163	103129	
-127	103229	Rx signal level changing slowly
-126.4	103621	Rx signal level steady
	103705	Track 2 reports midcourse maneuver completed; Sun acquisition has occurred;

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
	103705	Antenna preset angle accomplished; all S/C subsystems look normal
	103930	Tracking data to one min sample rate
-126.9	103940	AGC/signal strength matches curve
-127.1	104410	
	105530	Data transmitting one sec; data of motor burn to JPL
	105839	B-2-1 event; earth acquisition has occurred
-126.0	110010	Rx signal level holding steady
-126	110133	Rx signal level steady; correlates with the AGC curve
-126.2	110243	
-126.3	111100	
-126.4	111240	
-126.4	111350	
-126.2	112000	
	112100	RTC-0 initiated
	112138	RTC-0 completed
-126.3	112140	Rx signal level steady
	112300	RTC-0 initiated
	112339	RTC-0 completed
	112325	Data completed 1 sec samples through motor burn
-126.5	112436	
	112500	RTC-3 initiated
	112539	RTC-3 completed
	112543	B-20 event
	112600	Rx signal level changing
-113	112700	
-112.6	112720	
-112.0	112900	
	112930	Tx command modulation off
	113006	Tx on synthesizer in lock
-112.0	113215	Rx signal level steady
-112.1	114200	AGC -1.65 v
-112.4	120558	AGC -1.63 v
-112.5	121000	AGC -1.63 v
-112.7	123535	
-113.0	125414	
	130601	Hot line to JPL out
-113.1	131538	AGC -1.58 v
-113.3	133000	AGC -1.57 v
	133400	Hot line to JPL in

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
-113.5	134823	AGC -1.56 v
-113.8	140000	AGC -1.54 v
-114.0	141650	AGC -1.53 v
	141840	Woomera has acquired S/C; reported by JPL
-114.0	142128	AGC -1.53 v; this agrees with pre-calibrated curve
-114.0	143000	AGC -1.51 v
-114.2	144500	AGC -1.52 v
-114.4	150000	AGC -1.50 v
-114.6	151500	AGC -1.49 v
-114.7	152700	AGC -1.48 v
	152715	Servo/Rx optimizing
	152720	Changing Rx counter; counting discontinued temporarily
-114.4	153200	Optimizing completed; removed all offsets
	153424	New counter installed and checked for acceptable operation
	153840	Track 2 reports glitches on data telemetry transmissions to JPL
-114.8	154720	AGC -1.48 v
	154807	Station 12 examined time of glitches; noted indications were low but recognizable
-115.1	155900	AGC is -1.46 v
-115.2	161700	AGC -1.45 v
	162109	Hot line to JPL becoming intermittent between DSIF 12 and JPL
	163400	Spike B-20 on Channel 2
-115.5	163600	AGC -1.43
	163840	TM reports glitch at 163400 similar to earlier spikes
	164030	TM reports frequent glitches on B-20; apparently non-significant
	164130	Station 41 reports no evidence of similar spikes
	165336	Rx notes high noise bursts on panalyzer
	165345	Spike on Channel 2; similar to previous spikes; probably local noise
	165900	Station 41 reports no evidence of similar spikes
-116.2	165930	AGC -1.40
-116.1	170600	AGC -1.40 v

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 29/063415 to 29/184535

SIG STR (dbm)	TIME (GMT)	REMARKS
-116.6	174050	Track 2 advises that Station 12 reduce Tx power at 1830
	171810	Series of spikes on Channels 2, 8, 20, and B-19; attributed to noise
	172145	Maser trailer reports ignition spikes on panalyzor
	172241	RCA reports clock pulse
	172621	Maser trailer reports more ignition spikes
	172711	Maser reports noise dissappeared; appeared to be impulse type
	172919	Maser again reports heavy impulse type noise on panalyzor
	173148	AGC -1.37 v
	173329	Ignition noise coming from a tractor in use near transportation building
	173631	Maser trailer reports ignition noise on panalyser
	175848	Severe glitch on Maser panalyzor
	180650	Maser trailer reports heavy ignition noise on panalyzor; caused by truck hauling tractor from site
	181535	AGC -1.54 v
	183000	Tx power going down; 20 db reduction as scheduled
-117.2	183031	S/C AGC at 36
	183100	S/C AGC at 37
	183144	S/C AGC at 42 = 20 db signal change
	183233	S/C AGC at 43
-118.4	183710	AGC -1.32 v
-117.6	183800	
-117.6	184000	
-121.9	184058	Servo in pre-limit
	184121	Doppler agrees with predicts
	184258	Signal level dropping
	184231	
	184241	Tx off; bad data on Rx; going to two-way 2 station doppler
-136.1	184303	TM lost lock; recovered
	184405	Signal level dropping
	184419	Data shows Rx out of lock; Rx in good data
	184535	Station 12 off of S/C; Woomera now tracking; end of First View Period

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-11

VIEW PERIOD: 29/071712 to 29/184656

SIG STR (dbm)	TIME (GMT)	REMARKS
-163	071712	Signal acquired
-159	071820	
-158	071915	
-157	071954	
-155	072005	
-153	072036	
-151	072119	
-149	072205	
-145	072255	
-143	072341	
	072343	
-140	072419	
-139	072430	
-138	072441	
-136	072512	All TM discriminators in lock; Rx in good data
-131	072605	
-128	072636	
-125	072702	
-121	072748	
-120	072820	
-117	072916	
-115	072952	
	073000	
-113	073041	
-113	073236	
-113	073546	
-113.5	073933	
	074140	Optimizing antenna position Stopped optimizing; no improvement in signal level
	074545	
-114	074623	
	074705	
	075100	
	075150	
-113.5	075915	
-114	080000	
-114	081000	
-114	082000	
-113.5	082316	
-113.5	083200	
	084000	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 29/071712 to 29/184656

SIG STR (dbm)	TIME (GMT)	REMARKS
-113.5	084242	Servo back in slave
	084400	
	084523	Servo out of slave; bad commands
	084600	Back in slave
	084844	Out of slave
	084912	Back in slave
	085445	B2-1 and B20 events
	085850	B-20 event
-114	090000	
-115	090415	
-115	091500	
	091940	Antenna is being moved off S/C for gain checks by about 10 degrees
	092014	All channels out of lock
	092100	Rx in bad data
	092200	Maser +10 dbm paramp +20 dbm
	093300	Data stopped 1 per min sampling of echo doppler
	093641	In lock Rx; back in slave; B-20 and 8 channels in lock; Rx in good data
	093740	Channel B-2 in lock
	093800	Started 1-per-sec doppler sampling (echo's)
	093948	Momentary bad commands
	094041	B-20 event
	094057	Signal level varying between -130 and -135 dbm
-128	094145	
-128	094150	
-127	094159	
-127	094205	
-127	094218	
-127	094301	
-127	094325	
-126.3	094720	
-125.7	095846	
	100040	B-20 event
	100045	B-2 out of lock
-125	10141	
	100150	B-2 in lock
-126	100156	
-124	100209	
-127	100225	
-126	100236	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 11

VIEW PERIOD: 29/071712 to 29/184656

SIG STR (dbm)	TIME (GMT)	REMARKS
-124	100245	
-125	100252	
-124.1	100300	
-127	100323	
-126.5	100340	
-126.5	100500	Momentary bad servo commands
	100840	60-cycle Rx bandwidth
	100850	-126.5
	101000	Momentary bad commands
	101009	B2-1 event
-123	101028	
-123.5	101044	
-126	101049	
-125	101055	
-122	101130	
-128	101150	
-124.5	101202	
-127	101301	
-131	101326	
-125.5	101401	
-131	101449	
	101500	Momentary bad commands
-137	101535	
	101622	10-sec time constant
-138	101628	
	101719	B-2 and B-20 in lock
-140	101728	
	101747	20-cycle bandwidth
-140	102000	
-139.5	102712	10-sec time constant
-139	103202	
-150	103210	
	103121	Discriminators out of lock
-137	103247	
	103212	-130 all discriminators in lock
-123.5	103419	
-126.5	103630	
	104520	-127
	105839	B2-1 event
-126.5	111107	
	112541	B-20 event
-128	112600	
-114	112650	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-11

VIEW PERIOD: 29/071712 to 29/184656

SIG STR (dbm)	TIME (GMT)	REMARKS
-113	112800	
-112.5	112815	
	114320	Rx printout is reading 2 sec slow
-112.5	120000	AGC -1.4
	122240	Rx printout is reading 9 sec slow
-112.5	123000	
	123650	Data back on sending sample rates one per min
-113	130000	
	130245	Rx printout is 11 sec slow
	133300	Resetting Rx printout clock
-112.6	150000	
-112.5	153000	
-111.5	153830	
-111.3	163000	
-111.0	173000	
	175344	Data on in modified mode; sample rate one per sec
-111.3	180000	
	182650	Rx switched to 60-cycle bandwidth
-112.0	183000	
-112.5	183730	
-113	184318	Rx in psuedo two-way
	184500	Data off
	184656	All equipment out of lock; end of track

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 29/141355 to 30/014950

SIG STR (dbm)	TIME (GMT)	REMARKS
	141355	Rx in lock
	141400	S/C AGC is -100 dbm
-120	141500	
-117	142700	
-114	144300	
-123.6	150600	
	151200	Noise on Dynamic Phase error from TM
	154919	TM has reported large spikes on Channel 2
-113.9	154300	Rx AGC
	162500	Start of Rate 4 sync on TM
	162630	High speed run started
	162635	High speed run finished
	163600	WWVH time checked; 31 mile sec delay
-113.14	163600	
-113.3	172600	
-113.3	174300	
-113.5	175500	
	180737	TM reports blips on Channel B2 and B20
-113.6	181340	
	181410	TM reports High frequency noise Channel HA error Channels
	181730	TM reports large blips on Channel 2
	182800	S/C AGC -104 dbm
-113.7	183000	
-113.9	183500	
-113.8	183700	
	184000	S/C AGC -123 dbm
	184222	Tx on and doppler good
	184300	S/C -113 dbm
	200700	Tx reports interference on modulation channel
	210100	Data predicts now coming in
	210200	The S/C handover between DSIF 41 and 51 will be conducted under non-standard conditions due to radio propagation
	211400	TM reports increase in Tx forward power of approximately 20 w
	214103	Report that Channel 2 shows a square pulse of opposite polarity to normal, lasting approxi- mately 4-5 sec followed shortly by a spike
-117.2	230800	
	233900	Rx equidistant AGC -0.246 v = -117.7 dbm
	000030	Servo reports that HA did not drive for about 3-4 sec

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 29/141355 to 30/014950

SIG STR (dbm)	TIME (GMT)	REMARKS
-118	005700	
	005800	Start reducing Tx power for transfer of S/C
	005900	TM verify Rx -118 dbm signal level
	012240	Tx power can be reduced
	012500	Transfer procedure change-over started
	013100	Tx forward power reduced 10 db
	013000	Doppler data good
	013200	Rx apply 10-cps mod in 3-sec bursts
	013200	Tx mod on and applied
		S/C AGC is fluctuating
	013400	Tx power 25 w
	013600	TM lost local 400 and changed to S/C 400
	014000	Rx signal strength dropping rapidly
	014200	Servo is out of predicts
	014245	Servo brakes on in both angles
-135	014530	Tx off doppler data bad
	014515	10 cps came through
		Increase in S/C AGC
-154	014700	Rx all loops in lock
	014800	TM disc still dropping lock; Rx -151
	014920	All TM disc out of lock
	014950	Rx out of lock at -158.0 dbm
	015000	Stopped data sampling

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 29/220245 to 30/091203

SIG STR (dbm)	TIME (GMT)	REMARKS
	220245	Rx in lock
	220302	Data started sampling
-135	220340	
-132	220422	Rx bandwidth 20 cps
	220448	TV normal
	220630	Servo in auto
-117	220730	
-116	221047	
	220422	Started punching telemetry tape
	220530	Started Tx telemetry data
	223500	Switched telemetry to alternative circuit; comms chief instructions
-114.8	225030	AGC +0.40 v steady
	224800	Data condition code indicator intermittent (showing Rx out of lock)
	230600	Rx switch to bad doppler
	231100	Data disconnected Rx doppler input
	231230	Data replaced doppler input from Rx
	233640	Data replaced gating card in doppler cage
	233640	Rx switched to good doppler
	003800	Sent tracking report
	005000	All telemetry discriminators out of lock
	005100	All telemetry discriminators back in lock; faulty relay
	012237	Point 9 change TV channel
	013110	Rx to 60 cps
	013426	Rx zero static phase error
	014513	Tx ON 200 w
	014536	Two-way verified
	014924	S/C AGC -108 dbm
	015047	Rx switched to good data
	015047	Telemetry switched to 400 cps
	015209	Rx to 20-cps bandwidth
	020600	RWV OFF (punch faulty) will install spare punch
	022428	RWV ON; spare punch fitted
	052627	Stopped digital printer for cleaning
	053926	Noise spike on Channel 2 (1/2 CM - neg)
	060100	TM stopped as a result of propagation conditions (RA-6)
	060900	TM going out
	063000	Tx digital clock shows 17-sec gain + 2 sec per 1/2 hr av

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 29/220245 to 30/091203

SIG STR (dbm)	TIME (GMT)	REMARKS
	064600	Tx digital clock corrected
	064800	29668232 Tx VCO; Tx reduces power
	065300	TM Decom to DECALOCK
	071220	Tx off
	071245	Rx in lock GM-32 after 5-sec drop-out
	071320	To 20 cps; good data
	071327	Decom sync switch to S/C position
	071500	RWV system switched OFF
	081400	Running high speed recorder
	081600	Restarted TM data; 081709.967 100-sec pulse ended
-120	090400	Signal strength dropping
	090657	High speed readout taken
	090806	Antenna stopped on horizon
-130	090836	Dropping
-157	091105	
	091203	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 30/065530 to 30/185949

SIG STR (dbm)	TIME (GMT)	REMARKS
	065530	S/C in lock; GM-31; Rx in 20 cps
	065600	Tracking data ON; all TM recorders ON
	065700	Tracking and TM data transmission to JPL started
	070048	Rx changed to 60 cps; signal level -159 measured and increasing
-152	070138	
-149	070249	
	070314	Tx ON - 200 w
-146.5	070401	
-143	070621	Varying
-140	070825	Increasing
-137.7	070859	
	070955	S/C signal appearing on panalyzor
-120	071139	Rx seeing 10-cps modulation; two-way lock
	071455	10-cps modulation ON; two-way lock confirmed; signal level -117.8 dbm; Rx in good data; Rx in 20 cps; servo in slave
	071519	Tx on synthesizer
-116.4	072119	
-117.1	074445	AGC -1.33 v
-116.6	080600	AGC -1.34 v equidistant with 51 and 12
	081000	Servo and Rx optimizing signal
	082935	Servo DEC/HA offset 0.1 each way; no appreciable signal change in signal level
-116.2	084936	
-116.1	090125	
-115.9	091551	
-115.8	093953	AGC -1.34 v agrees with AGC/signal level converter
	094100	Tx checking static phase error in synthesizer loop
	094200	Tx static phase error check completed
-116.2	095331	
	101934	Track 2 reports a change noticed in Channel 8 TM, request DSIF 12 look at it
	102038	No effects noticed in Channel 8 TM at DSIF 12
-116.0	102110	AGC -1.38 v, a difference of 0.8 db from the signal strength converter; converter being readjusted
	104100	Tx checking static phase error in synthesizer loop
	104159	Tx completed static phase error check - zeroed

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 30/065530 to 30/185949

SIG STR (dbm)	TIME (GMT)	REMARKS
-116.1	105110	AGC -1.37 v; AGC and signal strength converter agree
-116.1	110250	
	110450	Noise noted on panalyzor
-116.2	113120	AGC -1.36 v
-115.9	114635	AGC -1.37 v
-116.5	124720	AGC -1.35 v approx 0.3-db difference on the signal converter
-116.3	133528	AGC -1.33 v
-116.5	140025	AGC -1.31 v
	140800	Servo and Rx optimizing signal level
	141109	Servo optimizing indicated no change in signal level, 0.1 deg changes
-116.8	142025	AGC -1.28 v
-117.0	143428	AGC -1.27 v
	143559	Station 41 acquired the S/C
-117.1	150143	AGC -1.27 v
-117.5	151600	AGC -1.24 v
-117.7	153100	AGC -1.23 v
-118.0	154500	AGC -1.22 v
	154900	Rx static phase error is 0.11 v
-118.2	160100	AGC -1.20 v
-118.0	161500	AGC -1.17 v
	161550	Rx checked sideband power of the Rx against the standard wideband chart; measured power compared to that indicated on the chart
-119.2	163140	AGC -1.15 v
	163200	Checked dc telemetry phase detector balance; adjusted to +100 mv; reset phase balance on TM phase detector ± 5 mv
-119.6	165900	S/C equidistant to Station 41 and 12, AGC -1.128 v
	165938	Rx noticing noise on panalyzor
-120	170925	
	172433	Corrected time 172231; TV clock advance
-119.68	173449	AGC -1.11 v
-119.6	180200	AGC -1.11 v
-119.7	181500	AGC -1.107 v
	184000	Reducing Tx power; beginning S/C transfer
	184348	Tx stopped reducing power; approx 19 db reduction
-120.2	184500	AGC -1.07 v; the Rx ground static phase error is -0.155 v

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 30/065530 to 30/185949

SIG STR (dbm)	TIME (GMT)	REMARKS
	184850	Rx noticing ignition noise on panalyzor
-120.2	184900	
-120.3	185500	AGC -1.06 v
	185552	Antenna on pre-limits
-120.1	185630	
-123.6	185730	
-124.99	185745	
-121.2	185780	
-127.8	185800	
-131.5	185845	
-132.9	185900	
	185913	Tx OFF; Rx had not lost lock to this point
	185949	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 30/072850 to 30/192049

SIG STR (dbm)	TIME (GMT)	REMARKS
-164	072850	S/C signal acquired
-162	073005	
-160.5	073021	
-154.5	073156	
-152	073252	Rx in good data
-145	073410	
-140.5	073519	
	073528	All discriminators locked up
	073702	Wideband TM phase adjusted
-131	073803	
-125	073831	
-120.5	073926	
	074000	Servo in slave
-120	074030	
-119	074233	
	080413	Momentary bad commands to servo
	081134	Started optimizing
-119	081635	Stopped optimizing; no change in signal level
	083009	Momentary bad commands to 093234
	083100	System PC 141 synchronized with echo at 46 microseconds; spare PC 141 is at 22 microseconds
	094308	Started optimizing
	094630	Completed optimizing
-120	095040	
	102130	Data tape hung up; lost about 5 samples
-120	110000	
-120	120000	
	121700	No. 1 clock is 46 microseconds; slow as referenced to echo A12; No. 2 clock is 40 microseconds slow as referenced to echo DSIF 12
-119.3	130000	
	130800	
-119.3	140000	Noting interference on TM Channel 8
-119.5	150000	
-119	160000	
-118.8	163200	
-117.9	172830	
-117.5	173245	Very high noise spikes
-117.0	181200	
-117.5	183200	
	184000	Rx to 60-cps bandwidth

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-11

VIEW PERIOD: 30/072850 to 30/192049

SIG STR (dbm)	TIME (GMT)	REMARKS
-120.0	185900	Signal level varying from -116 to -120 Data tape No. 1 ran out
	190000	
	190106	
-126	190420	Servo moving Doppler loop dropped lock momentarily
-131	190450	
-139	190530	
-141	190550	Channel 8 out of lock B20 out of lock
-120	190720	
	191015	
-141	191140	B2 out of lock
	191620	
	191649	
-150	191750	Rx out of lock
	191905	
-164	191955	
	192049	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 30/143559 to 31/015930

SIG STR (dbm)	TIME (GMT)	REMARKS
-120.4	143559	Acquired signal in pseudo two-way lock
	143800	
	144812	B-2 event
	161800	-120.8
	165300	B-19 out of lock
-121.3	165900	
-122.3	174336	
	185426	Spike on B-2
	192000	HiLo +60 sec and then lo
	192500	60 sec
		29 66 81 49.6 at 19 18 26
-124.5	200000	
-124.45	201000	
-124.55	202000	
-124.45	203000	302010
-124.55	204000	
-124.95	205000	
-124.90	210000	
-124.80	211000	
-124.5	212000	
-124.9	213000	
-125.0	214000	
-125.1	221000	
	221317	Johannesburg has S/C in one-way lock
	222100	DSIF-51 S/S -124 dbm S/C below horizon
	222300	DSIF-51 S/S -117 dbm
	223000	DSIF-41 S/S -125.3 DSIF-51 -117.5
	224000	DSIF-41 S/S -125.4
	225000	DSIF-41 -125.4 dbm
	230000	DSIF-41 S/S -124.7 dbm
	230300	Tentative transfer time 2340
-124.8	232000	
	232500	Transfer procedure initiated
	232800	Informed track 2E, 41 ready for transfer
		Tx power will be reduced at 2335
	233500	Tx reducing power S/C AGC dropping
	234005	S/C AGC vise 10 cps mod DSIF-51 on 41 Tx off
	234200	Rx locked up pseudo two-way
	234800	At 2350 released from observing S/C
	235600	Paramp gain down 8 db
		Paramp gain down 6.5 db after adjustment

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-41

VIEW PERIOD: 30/143559 to 31/015930

SIG STR (dbm)	TIME (GMT)	REMARKS
-124.8	000900 003933 015930	Rx in lock Spike occurred on Channel 2 Ceased recording; S/C below horizon

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-51

VIEW PERIOD: 30/221317 to 31/091437

SIG STR (dbm)	TIME (GMT)	REMARKS
-124	221317	Rx in lock
	221339	Data started sampling
	221917	Below horizon
	221600	Started Tx tracking data
	221900	Started Tx telemetry data
-117	222300	In auto
	222300	Tape recorders on
	221000	
-117.5	223000	
-117.75	224000	Epscowest clock lags data clock by 90 microseconds
-117.75	225000	
-117.8	230000	
	230300	
-117.75	231000	
-117.9	232000	
	232500	Tx exciter on
	232516	Rx to 60 cps
	233522	S/C AGC dropping
	233730	S/C AGC -121 dbm
	233748	S/C AGC -124 dbm
	233828	S/C AGC -126 dbm
-117.75	234000	
	234000	Tx on; two-way lock verified
	234200	Rx to 20 cps; doppler switch to good; decom synch to S/C
-117.8	235000	
-117.9	000000	
-118	001000	
	002000	-117.8
-117.8	003000	
-117.8	004000	
-117.9	005000	
-117.9	010000	
-118	011000	
	011900	Telemetry stopped for 30 sec due to bad circuit
-118	012000	
-117.9	014000	
-118	015000	
-118	020000	
-118	021000	
-117.9	022000	
-118	023000	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-51

VIEW PERIOD: 30/221317 to 31/091437

SIG STR (dbm)	TIME (GMT)	REMARKS
-118	024000	
-117.9	025000	
-118	030000	
-117.9	031000	
	032500	Tracking report sent
-117.9	033000	
-118.1	034000	
-118.4	035000	
-118.3	040000	
-118.1	041000	
	041500	Sent tracking report
-118.1	042000	
-118.4	044000	
-118.3	045000	
-118.1	050000	
-118.1	051000	
	051500	Sent station tracking report
-118.3	052000	
	053000	Tx off; instructions from JPL; Rx out of lock
	053014	Rx in lock; one-way
	054000	Tx on; Rx out of lock
	054014	Rx in lock; two-way
-118.5	055000	
-118.5	060000	
-118.5	061000	
-118.5	063000	
	063600	Tx clock corrected after having stepped 3 sec fast
-118.5	064000	
-118.5	071000	
	071500	Starting transfer procedure with 10-cps modulation
	071526	Rx bad data; 60-cps bandwidth
	071600	Tx zeroing SPE
-118.5	072000	
	072030	Instrumentation to decalock
	072500	Tx reducing power
	073016	Rx off
	073034	Rx momentarily out of lock; now GM-32 with DSIF-12
	073045	20 cps bandwidth
	073058	Rx to good data
-118.7	074000	AGC +0.78 v
-118.5	075000	AGC +0.75 v

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 30/221317 to 31/091437

SIG STR (dbm)	TIME (GMT)	REMARKS
-118.9	082000	
-119.0	085000	
-121	090700	Signal strength falling
	090900	Servo sees horizon in TV screen
-130	091100	Dropping
	091130	Antenna stopped at horizon
	091437	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 31/070056 to 31/132549

SIG STR (dbm)	TIME (GMT)	REMARKS
-151	070056	S/C acquired
-152.5	070350	
-157	070751	
-160	070754	
-158.5	070814	
-154.5	070845	
-152	070905	
-150	070922	
-149	070937	
-146.5	071014	
-148	071110	
-147.6	071339	
-145	071426	
-143	071500	
	071516	10-cps modulation visible from DSIF-51
	071546	C2 completed; Rx out of lock
	071624	Rx in lock
	071647	60-cps bandwidth; Rx in lock
-124.1	071932	
	072049	All decom rates in sync
	072127	Servo in slave
-120.0	072136	Servo in slave 072127
	073000	Tx on; 10 cps on; 200 w
	073105	Rx in two-way lock
	073113	Tx on to synthesizer
-119.6	073300	Rx to 20 cps; good data
	073545	Tx power dropped slightly
	073600	Tx power back to 200 w
	074400	Antenna to aided track
	074452	Servo back in slave
	074700	Rx reports noise on panalyzer
	074823	Track 2 requests RFI silence to begin at 0830
	075025	Track 2 will go along with GTS 1100 RFI
-119.6	075530	AGC -1.19 v
-120.0	080800	AGC -1.19 v
	081115	Request to remove Tx from rubidium for a frequency swing to check other channels for noise spikes
	081317	Permission granted to swing Tx frequency
	081450	Tx to step on rubidium; troubles noticed in TM channel B20

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 31/070056 to 31/132549

SIG STR (dbm)	TIME (GMT)	REMARKS
-119.6 -119.4	081710	Noise coming from a recorder; checking to locate and correct operating one recorder
	082310	Rx noted two heavy spikes on panalyzor
	083313	
	091415	
-119.4	092223	Clock TV advance; TM confirms the pulse
	092733	Tx balancing SPE synthesizer loop
	092800	Tx completed SPE checks
	093434	Signal strength converter agress with AGC curve
-119.4	095120	Rx noticing narrow width ignition spikes on panalyzor
	1000145	
	101329	Servo and Rx optimizing started
	102030	Terminal maneuver commands being verified with JPL
-119.3	102535	Tx balancing SPE synthesizer loop
	102600	Tx SPE is zero
	092750	Servo optimizing checks completed; swings ± 0.077 no change in signal level
	103135	Agrees with signal strength converter
	105741	Permission granted to take Tx off rubidium at 110000
	155849	Permission granted to go on command modulation at 110100
	110000	Tx off rubidium synthesizer
	110825	Rx noticing ignition noise on panelyzor
	111420	Track 2 instructed DSIF-12 to hold commands
	111530	RTC-0 initiated
	111608	RTC-0 completed
	111730	RTC-0(2) initiated
	111809	RTC-0(2) completed
	111930	SC-4 initiated
	112010	SC-4 completed
	112013	SC-4(B20) event
	112018	B-2-1 event
	112130	SC-5 initiated
	112210	SC-5 completed
	112212	SC-5 (B20) event

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/070056 to 31/132549

SIG STR (dbm)	TIME (GMT)	REMARKS
	112330	SC-6 initiated
	112410	SC-6 completed
	112413	SC-6 (B20) event
	112601	Reading binary readouts for stored commands to track 2
-119.6	112437	Command message gold coming in on TTY
	113250	
	114208	Ignition noise on Rx panalyzer
-119.9	114559	
	115100	RTC-0 initiated
	115138	RTC-0 completed
	115300	RTC-0(2) initiated
	115339	RTC-0(2) completed
	115500	RTC-8 initiated
	115538	RTC-8 completed
	115540	B20 event
-119.9	120229	
	120817	Command message HORN coming in on TTY
	121152	Command message INFORMATION coming in on TTY
-119.9	121619	
	122500	Data to one sec per sample; one per 10 sec sample to JPL
	122508	RTC-6 initiated; initiate terminal maneuver
	122547	RTC-6 completed
	122559	B20 event
	122602	B-2-1 event
	123039	Starting bandwidth checks
-118.7	123731	
	123520	B-2-1 event
	123757	Servo in aided track
	124037	Servo in slave
	125222	B-2-1 event
	125355	RTC-8 unloaded
	125427	Load RTC-7
	130233	RCA in the Green; reported via Track 2; confirmed by RCA/GTS
	130717	90 pt TM received; cameras in warmup
	130840	Channel F video! Track 2 reports video clean and good
	131051	B-2-1 event

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 31/070056 to 31/132549

SIG STR (dbm)	TIME (GMT)	REMARKS
-118.6	131117	P Channel in warmup
	131207	P Channel video in full power!
	131208	Both video channels on!
	131550	B-2-1 event
	131807	
	132215	TM data is excellent
	132355	No yaw pitch or roll indicated on TM
	132438	F solar panel temperature 103° F
	132549	Impact; Ranger VII mission over and successful

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 31/073015 to 31/132550

SIG STR (dbm)	TIME (GMT)	REMARKS
-164	073015	Signal acquired
-160	073140	
-154	073300	
	073330	Rx in good data
-150	073400	
-145	073448	
-140	073540	
-136	073630	
-129	073809	
-124.5	073922	
	074000	B-2 event
	074009	Servo in slave
	074200	B-20 in lock
-120.3	074310	B-2 event
	074800	
	074915	
		Phasing of telemetry completed; experiencing noise on RF; visible on analyzer
-120.2	075905	Momentary bad commands
	075947	
	082330	
	082414	
	082814	
		Completed optimizing; offsets HA-0020; DEC+0200
-120.4	083850	Momentary bad commands
-120.5	092400	
-120.2	093000	
-120.3	100000	
	100830	Optimizing antenna
-120.2	100900	Completed optimizing - HA - 0020; DEC +0100
-120.2	103100	Station 12 is off rubidium standard at 110000 by permission of net control
	105800	
-120.4	110000	Station 12 reports Tx off standard 110000; command modulation on a 110100
	110120	
-120	113000	Momentary bad commands
-121	115035	
	115820	
-121	120000	
-121.4	120335	

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 31/073015 to 31/132550

SIG STR (dbm)	TIME (GMT)	REMARKS
	120715	Optimizing antenna
	121045	Optimizing completed offsets HA - 0020; DEC + 0040
-121.7	121500	Started bandwidth checks
	121654	Completed bandwidth = 3.6 Mc (± 1.8)
	123747	Aided track due to bad commands
	124033	Out of aided track
-121.5	124500	
-121.5	125500	
	125940	Momentary bad commands
-121.5	130000	
	130717	90 point TM
-121.5	130837	F Channel video
-121.5	131210	P Channel video
-121.5	131907	
	132550	Impact; Rx out of lock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 71

VIEW PERIOD: 17/170501 to 17/171243

SIG STR (dbm)	TIME (GMT)	REMARKS
-80	073000	All equipment on for warmup; Tx on dummy load
	083000	Started station calibrations
	091500	Measured Tx power output at +42.0 dbm
	103000	All station calibrations are complete
	103000	PAA men have started the 100 kw standby generator
	103500	PAA men have 100 kw generator power on line to switch to in event of a Cape critical power failure.
	112000	Started preliminary conditions per Procedure 3R309.07
	114500	Rechecked RWV command mod. carrier suppression, 3 db
	115000	Started communication checks to hangar A0 and Pad 12
	120200	Completed communications checks
	122400	S/C power ON
	124000	Ground Tx is radiating to S/C
	124100	Started transponder threshold checks
	125500	Transponder threshold checks complete Threshold = -141 dbm
	134000	Reported that Station-71 was ready by voice & TTY
	143200	L-90 Frequencies reported by voice & TTY
	144400	L-80 pretracking report by TTY
	161000	L-40 frequencies reported by voice & TTY
	162000	L-35 Station-71 was reported ready by voice & TTY
	163700	L-20 performed the launch doppler shift correction for two-way lock; Tx freq. = 29.668180 to 29.668680 Mc
	170501	Liftoff
	170722	Momentary loss of lock
	171243	Lost lock as S/C disappeared over the horizon.
	171410	Tx off

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 17/173320 to 18/073759

SIG STR (dbm)	TIME (GMT)	REMARKS
-90	173320	Rx in lock
	173350	Decom in lock
	173401	Servo in auto; two-way confirmed
	173418	Tx to 200 w
	173551	Rx to bad data
	173554	Tx changing frequency to 29.668339
-91	173710	Rx to good data
	174300	
	175125	Tx OFF
	175130	Rx out of lock
	175146	Rx in lock; GM-12
	175149	Tx ON
	175150	Rx out of lock
	175300	Rx in lock; GM-22
	175355	Two-way confirmed
	175455	Rx momentarily out of lock
	175500	Rx out of lock
	175525	Rx in lock
	175835	Rx to bad data; Tx adjusting frequency
	175946	Rx to good data
	180801	B-2-1 event blip
	181114	Demod in lock
	182500	10 cps modulation to indicate transfer preparation
	182603	Rx to bad data
	182633	Rx to 60 cps
	182700	Tx reducing power
	182807	Tx at 20 w
	182900	S/C AGC down
	183200	Rx momentarily out of lock
	183204	10 cps modulation seen
	183250	S/C AGC up
	183300	Tx OFF; GM-32
	183309	Rx to 20 cps B/W
	183326	Rx to GM-32
	183358	Rx out of lock
	183442	Rx in lock
	183507	Rx to good data
-115	190000	+0.2 v
-116	193000	+0.32 v
	195500	Transfer initiated
	195735	Rx to 60 cps B/W
	195745	TM to decalock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 17/173320 to 18/073759

SIG STR (dbm)	TIME (GMT)	REMARKS
-115	195830	S/C AGC down
	195906	Rx to two-way
	195912	Rx out of lock
	195920	Rx to bad data
	195929	Rx in lock
	200000	Tx on 25 w; GM-22; 29.668520
	200035	Tx to 200 w
	200119	Rx to good data
	200129	TM to S/C
	200145	S/C AGC -85 dbm
	200315	Rx to 20 cps B/W
	203000	+0.24 v
	210000	Command modulation on
	211200	RTC-0 verified internally
	211300	RTC-3 verified internally
-116	211500	RTC-0 loaded
	212100	RTC-0 initiated
	212138	RTC-0 verified
	212300	RTC-0 initiated
	212338	RTC-0 verified; +0.33 v
	212500	RTC-3 initiated
	212539	RTC-3 verified
	212539	B-20 blip
	212600	S/C AGC going down
	212620	AGC building
-107	212700	
	213100	Command modulation off
	215434	Rx to bad data
	215440	Rx to 60 cps B/W
	215505	TM to decalock
-101	215700	Tx reducing power by 10 db
	215720	Tx at 20 w
	215820	
	215830	Tx to 10 w
	215930	S/C AGC -105 dbm
	220004	S/C AGC -93 dbm
	220100	Tx OFF
	220130	Rx out of lock
	220147	Rx in lock
	220200	Rx to good data
	220230	TM to S/C
	224637	Rx out of lock
	224655	Rx in lock; possibly due to heavy electrical storm

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 17/173320 to 18/073759

SIG STR (dbm)	TIME (GMT)	REMARKS
-110.7	231800	Rx to 60 cps
	231815	TM to decalock
	231825	Rx to bad data
	231840	Rx out of lock
	231900	Rx in lock
	232000	Tx ON
	232018	S/C AGC up
	232044	Rx to good data
	232050	Rx to 20 cps B/W
	232101	TM to S/C
	045000	Pre-acquisition report sent
	052923	Rx to 60 cps and bad data
	053100	Rx to good data and 20 cps
	053200	Hydraulic leak in dec
	054018	Dec brake on; hydraulic pump dumped and portion of return line replaced with flex hose
	054230	Dec pressurized and brake off
	061500	10 cps modulation
	061533	TM to decalock
	061528	Rx to 60 cps B/W
	061700	Tx reduced power
	061930	S/C AGC down
	062650	S/C AGC up
	062728	Tx OFF
	062751	Rx to C3
	062752	Rx out of lock
	062815	Rx in lock
	062845	TM to S/C
	065700	Equidistant measurements; S/C AGC 032 signal level -0.16 v
	072328	Servo at pre-limits
	073014	Discriminators starting to drop out of lock
	073730	Rx momentarily out of lock
	073759	Rx out of lock; end of pass

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 17/175400 to 18/001300

SIG STR (dbm)	TIME (GMT)	REMARKS
-130	175400	Rx on sideband
-133		Rx relock
	175500	Tracking data being transmitted
	175600	Nose spikes on all TM channels
-103	175650	
	175710	400 cps to Rx
	175800	Noise spikes disappeared
-108	175816	
	175909	Servo to good data
	180000	Servo to auto
	180555	Frequency counter defective on last digit
-103	180856	
	182000	41 and 51 to execute two-way transfer at 1830
-109	182200	
	182509	10 cps mod is seen at 41 Tx
	182605	Rx out of lock for a moment
	183100	Tx is ready at 200 w
	183200	Tx ON at 200 w
	183239	Rx in two-way lock good bad to good
-111	190610	
	194430	Rx to bad data
	194500	Tx commence Xa change
		Rx in 60 cps bandwidth
	194920	Tx Xa change completed
	195800	Tx to reduce power by approximately 20 db
-112.4	195200	
	195645	Decom to decalock
	195833	Tx reducing power
	195848	Tx power reduced
	200147	Tx turned OFF
	200148	TM back to S/C lock
	200330	Rx on sideband
-115	200600	AGC -0.5 v
	203602	B-2-1 event
	204900	BA-8 executed, Earth acquisition
	211927	Spike on Channel 2 address
-125	212625	Rx S/S is falling
	224500	Rx to bad data and 60 cps bandwidth
	224650	Rx out of lock
	224700	Rx in lock
	224726	Rx 20 cps bandwidth
	224940	Good doppler data
	231130	Transfer to DSIF 51 at 2320

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 17/175400 to 18/001300

SIG STR (dbm)	TIME (GMT)	REMARKS
	231800	Tx reducing power
	231820	Tx 10 db down
	231840	S/C AGC 0.036
	232000	S/C AGC 0.032
	232110	Tx OFF
	232112	Rx to C3 mode
	232140	Rx momentarily dropped lock
	232200	Rx back to 20 cps good data
	232757	Antenna is in limits
	233355	Rx to ACQ-AID
	000900	TM out of lock
	001300	Rx out of lock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 18/055729 to 18/163000

SIG STR (dbm)	TIME (GMT)	REMARKS
	043000	5 db loss in Rx subsystem determined to be a shift in AGC curve; spare 455 kc IF amplifier now installed, due to 1.1 v on gas test with original module; recheck of Maser and Paramp gain was found to be overall 1.3 db high; this was reset to give correct Rx system threshold at -165 dbm; the AGC curve has Rx saturation for gain at -163 dbm
	051500	Wide band phase amp in Rx out of balance
	054644	Antenna on point
-140	055729	Rx in lock; recorders on; TPH on; Rx may be on sideband
-131	055900	TM sending data Rates in sync
-129	060029	
-126	060144	
-118	060237	
-113	060329	
-110	060424	
-109.5	060501	
	060605	Antenna in track, following predicts
	060609	Servo in slave
-109.8	060800	Rate 4 sync did not lock
	061505	10 cps MOD on
	061545	Rx in 60 cps
	061606	Rx to bad data
	062600	Tx on; no loss of lock; two-way lock
	062638	Two-way confirmed via 10 cps check
	064850	Noise bursts noticed on right side of analyzer
-108.7	065700	Equidistant; AGC -0.89 v; variation 1.0 db
	070850	Servo to HA narrow bandwidth at 0.05 cps
	072128	Rx reports noise on analyzer; appears to be ignition
	072425	Receiving command message: KILL
	072843	Voice verification of command message: KILL
	072950	Rx to bad data
	073145	Rx to good data
-108.7	073155	AGC -0.88 v; variation 0.1 db
	073540	Servo had bad command; back in slave almost immediately
	075658	Noise spike noticed on TM
	080220	Rx reports heavy noise spikes; appear to be ignition
-108.7	080302	AGC -0.888 v; varying 0.1 db

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 18/055729 to 18/163000

SIG STR (dbm)	TIME (GMT)	REMARKS
-108.8	083030	AGC -0.876 v; varying 0.1 db
	083800	Command modulation ON; carrier suppression 2.85 v = 3 db
	085000	1-RTC-0 initiated
	085038	1-RTC-0 verified
	085200	2-RTC-0 initiated
	085238	2-RTC-0 verified
	085400	SC-1 initiated
	085438	SC-1 verified
	085440	B-20 event
	085443	B-2-1 event
-109	085500	AGC -0.857; 0.1 db
	085600	SC-2 initiated
	085638	SC-2 verified
	085640	B-20 event
	085800	SC-3 initiated
	085838	SC-3 verified
	085842	B-20 event (SC-3)
	090940	Receiving command message: LOOP
	091055	Voice verification of command message: LOOP
	092640	AGC -0.820 v; 0.1 db
-109.6	093600	1-RTC-0 initiated
	093638	1-RTC-0 verified
	093800	2-RTC-0 initiated
	093838	2-RTC-0 verified
	094000	RTC-3 initiated; antenna switch over
	094038	RTC-3 verified
	094040	B-20 event; signal level dropping
	094118	-130 dbm to -136 dbm
	094212	Signal level holding
	094245	Signal level confirmed
-124 -123.6	094933	Rx reports excessive noise on panalyzor
	095021	Rx reports continued noise; very bad
	095045	Receiving command message: MIND
	095130	Receiving command message: NOTE
	095207	Voice verification of command message: MIND
	095225	Rx continues to report excessive noise
	095640	AGC +0.227 v; 0.1 db
	095955	Voice transmitted command message word: TIME
	100000	RTC-4 initiated
	100038	RTC-4 verified
-125	100044	B-2-1 event
	100109	RTC-8 loaded

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 18/055729 to 18/163000

SIG STR (dbm)	TIME (GMT)	REMARKS
-163	100231	Rates 1 and 2 out of sync; all discriminators out of lock
	100300	Rx out of lock
	100301	Rx in lock
	100320	Rx out of lock
	100404	Rx varying in and out of lock; staying close to threshold
	100451	Signal level holding
	100500	Rx in lock; signal level varying between -150 and -162 dbm
	100549	Rx out of lock
	100600	Rx in lock
	100645	Rx out of lock
-140 -160 -153	100901	Rx continues in and out of lock; signal level -150 to threshold
	101026	Rx in lock
	101113	Rx in and out of lock
	101310	Rx in lock
-145 -145	101439	Rx in lock
	101503	Rx continues marginal in and out of lock
	101646	Rx out of lock; searching
	101717	Rx in and out of lock
-145 -145	101720	Out of lock, searching
	101914	In and out of lock; signal level at threshold
	102144	Rx in lock with good doppler
	102312	
-126	102409	Rx in and out of lock; at threshold
	102449	-150 to -157 dbm Rx signal
	102712	
	103100	Rx signal counter recalibrated
-123.9	103050	Station AGC in place of S/C 6
	103845	Rx signal level -122 to -123 dbm; AGC -0.25 to 0.35; variation 1
	105700	AGC +0.256 v; 0.1 db
	112223	Receiving command message: OVER
-125.5	112341	Voice verification of command message: OVER
	112700	AGC +0.394; 0.1 db
	113000	1-RTC-0 initiated
	113038	1-RTC-0 verified
	113200	2-RTC-0 initiated
	113238	2-RTC-0 verified
	113400	RTC-3 initiated; reloaded RTC-3 in RWV
	113438	RTC-3 verified
	113440	B-20 event

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 18/055729 to 18/163000

SIG STR (dbm)	TIME (GMT)	REMARKS
-132	113510	RTC-3 unloaded from RWV
-112	113540	
-111.5	113630	
	113640	Command modulation off
	114100	Computer put in new drive tape
	121000	Transfer to DSIF-41 at 1500
-111.8	122000	AGC variation less than 0.1 dbm; AGC
	122500	voltage -0.682
	123449	Rx reports new doppler predicts are correct
	130209	Synthesizer on
	130302	Rx to good data
	130445	Tx dropped to 145 w
	130540	Tx power rechecked at 135 w
	130629	Tx increasing power to 200 w
	130637	Tx increased to 200 w
	131144	Tx increased to 225 w, no change to beam voltage
	131355	Tx increased to 230 w
	131520	Tx reducing power
	131530	Tx power at 200 w
	131615	Tx power increased; adjusted to 200 w
	131645	Tx beam power at 18 k
	131712	Tx holding at 200 w
-112.6	132639	AGC -0.619 v; variation 0.1 db
	133220	Tx at 8 kv and 200 w
	142000	Equidistant: -0.596 v AGC, -112.95 dbm; S/C data #28 = -100 dbm
-112.9	142714	AGC -0.596 v, 0.1 db
	143735	Rx reports noise spikes appearing; possibly due to morning traffic
	145545	Rx in 60 cps bandwidth
	145639	Tx reducing power
	145801	Tx in 10 w configuration
	145921	Tx in 5 w configuration
	145955	Tx in less than 2 w configuration
	150147	Tx off
	150295	Rx in 20 cps bandwidth; C-3 doppler 1503
	150311	41 acquired two-way
	150345	Rx good data
	152619	Ignition noise in Rx

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 18/055729 to 18/163000

SIG STR (dbm)	TIME (GMT)	REMARKS
-112.5	152800 154850	Rx reports hearing ignition noise - construction equipment
-112.7	155200 155415 1600105 162830	
-120	162934 163000	Rx to bad data Rx to good data Signal level beginning to decrease Rx out of lock; discriminators out of lock; servo off

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 18/120350 to 19/005240

SIG STR (dbm)	TIME (GMT)	REMARKS
-140.5	120350	Rx in lock
	120500	Tracking data going out
	120600	Rx to 20 cps bandwidth
	120700	1st good data sampled
	121552	Data transmission started by TM
	121730	All rate in sync on decom
	122740	Station to track from acquire mode
	122937	Servo to auto
	123030	Servo angle data to good
	123145	TM switching to Rx mode
-115	135035	Small blip on Channel B-2-1
	142000	Equidistant measurement taken at DSIF-41 -0.605 v -113.0 dbm
	145350	Tx set for 200 w for Two-way transfer
	145515	Rx on 60 cps B/W
	145700	Rx on all loops in lock
	150139	Tx on at 200 w F 29668309; S/C SQE 035 AGC 035
	150600	TTY circuit out on Charlie
	172047	Event on Channel 8; clock pulse (3.2 voltage step)
	220000	Tx commenced Xa change
	220400	Tx at new Xa
-112.8	220440	Rx to 20 cps B/W; good data (doppler)
	221100	AGC 0.610 v
	222800	S/C PGC; 035; -105.1 dbm; Station 51 -0.062 v -111.8 dbm
	222048	Fault noticed with TM display
	222231	Rx in and out lock relay adjusted
	231300	DEC error trace on CEC adjusted to give additional spacing
	232200	All stations man line 1
	232430	Logged 3 burst on 10 cps modulation
	232635	Rx SPE zeroed
	232817	Tx now at reduced level
	232920	TM to decalock
	233100	Indication of 10 cps modulation
	233247	Tx off
	233400	S/C 043 AGC
	233440	Rx out of lock
	233442	Rx in lock; one-way
	232628	Rx out of lock
	232638	Rx in lock; two-way

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 18/120350 to 19/005240

SIG STR (dbm)	TIME (GMT)	REMARKS
	232640	10 cps modulation indicated
	233800	Rx doppler is within 4 cps of correct predicts
	234020	Amended note: doppler is 77 cps high
	234130	Rx dropped lock momentarily due to change of mode
	234230	Rx doppler data switch to good
	234430	TM revert to S/C lock
	234132	TM rates out of lock
	234633	TM rates back in lock
	000400	0.035 S/C AGC
	003205	Ant stopped tracking
	003500	TM HI-LO to LO; Rx to acquire mode
	005014	TM stopped recording
	005240	Rx out of lock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 51

VIEW PERIOD: 18/195928 to 19/080055

SIG STR (dbm)	TIME (GMT)	REMARKS
-121	195928	Rx in lock; C3
	195930	Servo in auto
	200230	TM started punching data
-113	200800	
-112	201000	
	201815	Decom all rates in sync
-112	205000	
	213000	TM remained in HI-LO mode until 214500 due to operator error
-111.8	221050	Equidistant measurements; S/C AGC 035; signal level 0.062 v
	232425	10 cps modulation seen
	232510	Rx to 60 cps B/W
	232515	TM to decalock
	232526	Rx to C2 and bad data
	232528	Rx out of lock
	232542	Rxin lock
	232718	10 cps modulation seen
-115	232820	
	233000	Tx on 200 w
	233010	Rx out of lock
	233040	Rx in lock
	233425	Tx OFF
	233505	Rx dropped lock momentarily
	233620	Tx ON; 200 w
	233630	Rx dropped lock momentarily
	233730	Two-way lock confirmed
	233945	Tx to synthesiser
	234135	Rx to 20 cps B/W and good data
	001600	S/C AGC -115 dbm; Rx AGC dropping
	001645	Servo to aided track; fault in HA phase detector
	004137	Rx dropped lock momentarily while investigating fault
	004700	Servo to autotrack; HA phase detector adjusted
	013052	Channel 8, point 9 increased to 4.2 v
	062500	10 cps modulation transmitted
	062528	Rx to 60 cps B/W
	062537	TM to decalock
	062737	Tx reducing power
	062920	Tx at 2 w; S/C AGC 043

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 18/195928 to 19/080055

SIG STR (dbm)	TIME (GMT)	REMARKS
-112.5	063010	S/C AGC up 035
	063035	Tx OFF
	063057	Rx to C3; Rx out of lock; Rx to bad data
	063106	Rx in lock
	063112	Rx out of lock
	063119	Rx in lock
	063150	Rx to 20 cps B/W and good data
	063155	TM to S/C
	071300	Equidistant measurements; S/C AGC 035 -105.1 dbm
	071515	10 cps modulation observed
	071535	Rx to 60 cps B/W
	071545	TM to decalock
	071600	S/C AGC 034
	071740	Rx to C2 and bad data
	072005	Tx on 200 w
	072040	S/C AGC 036
	072120	Two-way confirmed
	072125	Rx to 20 cps and good data
	074505	10 cps modulation
	074550	Rx to 60 cps
	074556	TM to decalock
	074700	Tx reducing power
	075000	Antenna at horizon
	075053	Tx OFF
-150 -155	075110	Rx to C3 and 20 cps B/W
	075113	Rx dropped lock momentarily
	075600	Signal level dropping
	075740	AGC Rx -140 dbm
	075811	H9 sync pulse not obtained; discriminators out of lock
	075820	
	080000	
	080055	Rx out of lock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 19/060519 to 19/165952

SIG STR (dbm)	TIME (GMT)	REMARKS
-142.9	060519	Rx in lock
	060602	TDH Rx doppler at 1 sec sample rate
-132	060706	
-123	060830	
	061017	Rx good-bad data switched to good
-117.8	061340	Var ± 0.5
	061717	Servo using drive tape
	061750	Added +0.1 dec by servo for offset
	061853	All rates sync on rate 4 sync
	062240	Malfunction in Rx 10 cps monitor, no horizontal sweep; Tx turned ON audio osc to bring on sweep
	062518	3 bursts of 10 cps modulation
	062600	System set for 60 cps loop B/W
	062807	Tx on synthesizer
	063000	Tx ON 10 cps mod
	063025	Confirmed two-way lock by 10 cps
	063220	TM went to S/C
	063900	Rx reports exact transfer time read from impact counter to be 063002; +0.118540 sec
	065430	Antenna back on drive tape
	071300	Equidistance; -116.4 dbm, AGC -0.777 v
	071500	Tx 10 cps on 3 secs; 3 bursts
	071552	Rx to 60 cps B/W
	071630	Tx began reducing power
	071826	Rx to bad data position
	072106	10 cps mod present; transfer accomplished
	072158	TM decom aux back on S/C 400 cps
-116.4	072956	AGC -0.777 v, variation 0.1 - db
	074529	Bursts of 10 cps
	074603	Rx at 60 cps
	074627	Glitch on all Sanborn channels; also CEC
	075000	Tx ON
	075002	Rx noted glitch
	075024	10 cps on by Tx
	075039	10 cps on; two-way lock
	075041	10 cps off at Tx
	075127	Rx to good data; changed to 20 cps
	082100	Rx to bad data
	082000	Tx OFF synth and began adjusting frequency
	082305	Rx to good data
-117	083146	AGC -0.735 v, variation 0.1 db

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF-12

VIEW PERIOD: 19/060519 to 19/165952

SIG STR (dbm)	TIME (GMT)	REMARKS
-116.75	093314	AGC -0.750 v, variation 0.1 db
-117	102810	AGC -0.735, variation 0.1 db
	105000	Doppler 0.1 cps high; Rx gnd VCO 31.001474; Tx VCO 29.668300
-117.1	110000	
	110657	Rx noted glitch
	111500	Rx reports signal varying up and down on panalyzor but no AGC voltage change
-117.3	112700	ACC v -0.716; less than 0.1 db variation
	122039	Track reports noisy TDH data reception - from 1140
-117.5	122920	AGC -0.692 v, variation - 0.1 db
	123255	Rx to bad data
	123640	Rx to good data
	123739	Tx reports the backup synthesizers have less noise
	125500	Tx 10 cps on; Rx sees all 3 bursts
	125524	Rx to bad data
	125559	Rx to 60 cps B/W
	125656	Tx reducing power
	130000	Rx reports SPE glitch
	130021	Tx OFF
	130035	Rx sec 10 cps modulation transfer mode
	130129	TM back to S/C
	130139	Rx to good data
	132203	Rx reports momentary heavy noise spikes
-117.9	132925	AGC -0.67, variation 0.1 db
	140956	TM reports glitch
-117.5	142614	AGC -0.698 v, variation 0.1 db
	142859	TM reports some difficulty with the Sanborn strip chart Rx
	143600	Equidistance: -117.5 dbm, AGC -0.699 v; AGC data No. 36 = 108
	145124	Rx reports glitch
	145504	Rx reports 10 cps mod
	145529	Rx to 60 cps B/W
	145556	Rx in and out of lock
	150000	Tx ON; Rx reports glitch
	150010	Tx at 200 w
	150022	10 cps present; two-way lock; completed transfer of Station 41 to Station 12
	150101	Rx to good data
	150109	Rx to 20 cps B/W
	150230	TM back on S/C

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 19/060519 to 19/165952

SIG STR (dbm)	TIME (GMT)	REMARKS
-117.9	150311	Rx reports heavy noise bursts on panalyzor
	150500	Rx reports doppler on predicts
	152644	AGC -0.673 v, variation 0.1 db
	155858	Rx reports sharp heavy burst of noise
	160023	Rx to bad data
	160110	Tx OFF synthesizer
	160358	Rx to good data
-118.2	161500	Equidistant measurement: -118.2 dbm, AGC -0.648 v, DN 34 = -105 dbm S/C
	162940	AGC -0.645 v, variation 0.1 db
	164000	Tx turned on 10 cps
	164006	Rx secs 10 cps at 09 + 15 secs
	164030	Rx to bad data
	164039	Rx to 60 cps B/W
	164130	Tx reducing power
	164243	Tx in 5 w
	164503	Rx saw glitch; Station 41 in two-way; lost sync on all rates
	164512	Tx OFF
	164536	10 cps received; two-way completed
	164602	Rx in and out of lock momentarily
	164630	Rx to good data
	164927	Signal level decreasing
-122	165015	
-135	165155	
	165219	TM loosing lock on all channels
-139	165249	
-138	165500	
	165704	Channel 8 out of lock
	165710	Channel 2 out of lock
-152	165737	
	165758	All discriminators out of lock
	165810	Decom out of sync
	165952	Rx out of lock

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 19/122719 to 20/010220

SIG STR (dbm)	TIME (GMT)	REMARKS
-146	122719	Rx in lock
	123115	Rx good/bad to good
	123800	Data transmission started
-140	123924	Rx in lock
	124020	Rx out of lock for a few sec
	124120	Rx good/bad to good
	124230	Servo to auto
	124302	First good sample of data
	124700	Servo to good data
	125300	Analog data going out
	125510	10 cps modulation seen at DSIF-41
	125555	Rx to bad data
	130000	Tx ON at 200 w
	145503	10 cps modulation going out to S/C
	145530	Rx changed to 60 cps B/W
	145600	Decom on aux position
	150000	Tx OFF
	150115	Rx on 10 cps B/W
	161500	Equidistant measurement; -0.290 v; -116.7 dbm; S/C AGC 035 D/N
	164000	10 cps modulation seen at DSIF-41
	164020	Rx to 60 cps B/W
	164500	Tx ON at 200 w
	164600	Rx to C2 doppler and 20 cps B/W
	173107	Channel 8 pulse
	193750	Rx doppler data bad, 60 cps B/W
		Tx Xa change commenced
	194020	Tx on new Xa frequency
	194857	Rx dropped lock for 1 sec
		Discriminator out of lock
	194032	Rx back in lock after short period of out lock
	194518	Rx back to 20 cps B/W; doppler data good
	195200	Channel 2 is showing small deviation
	202222	Deviation of 1 mm on Channel 2
	203300	All stations man line 1
	203340	Tx mod applied
	203500	Rx 10 sec mod applied
	203541	Rx doppler data bad and 60 cps B/W
	203800	Tx reducing power
	203825	Tx at 10 db reduction in power
	203950	S/C AGC 036 to 041
	204015	10 cps mod received
	204025	Tx OFF

TABLE A-2
RANGER VII TRACKING OPERATIONS SUMMARY

STATION : DSIF-41

VIEW PERIOD: 19/122719 to 20/010220

SIG STR (dbm)	TIME (GMT)	REMARKS
	204116	Rx momentarily dropped lock
	204237	Rx 20 cps
	204320	Rx all loops in lock and good data
	222402	Rx equidistant measurement, S/C AGC 036, AGC -0.311 v, S/S -116.4 dbm
	235922	Rx in 60 cps B/W bad data
	000000	Tx Xa change commenced
	000230	Tx Xa change completed
	000240	Rx back to 20 cps good data
	003500	Rx 10 cps mod applied and verified
	003550	Rx doppler data bad and 60 cps B/W
	003800	Tx reducing power
	003820	Tx down 10 db
	004057	Tx OFF
	004100	10 cps mod viewed
	004215	Rx dropped lock for 1 sec
	004234	Rx 20 cps
	004240	Good data mode
	004325	Antenna in limits
	004754	Rx showing in and out lock indication due to antenna null; in lock on side lobe
	005235	Blip on B2 (may be due to discriminator out of lock)
	005822	All TM Channels out of lock
	010220	Rx out of lock; bad data

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 19/201600 to 20/080508

SIG STR (dbm)	TIME (GMT)	REMARKS
-113.9	201600	Rx in lock
	220110	Rx to 20 cps B/W
	220129	Rx to GM-32
	220147	TM to S/C
	222402	Equidistant measurement; S/C AGC -108.6 dbm; gnd Rx AGC PO 0.115 v
	003500	10 cps modulation observed
	003523	Rx to 60 cps B/W
	003615	Rx to bad data
	003633	Rx to two-way
	004000	Tx ON; 200 w; GM-22
	004005	Tx tripped; excessive forward power
	004026	Tx ON again
	004053	Two-way confirmed
	004136	Rx to good data
	004142	Rx to 20 cps B/W
	004148	TM to S/C
	010648	Signal strength appeared to fall 10 db for a short while
	010844	Repeat of previous anomaly
	012900	Decom manually resynced
	013620	Rx momentarily out of lock; TM rate 1 out
	013727	Rate 1 in sync
	013730	Rates 1 and 2 out of sync
	013823	Discriminators going in and out
	013830	All discriminators in except rate 1
	014249	Rate 1 floating in and out
	014340	Rx momentarily out of lock
	015703	Rx momentarily out of lock
	042725	Rx out of lock
	042753	Rx in lock
	062500	10 cps modulation ON
	062537	Rx to 60 cps B/W
	062540	TM to decalock
	062700	Tx reducing power
	062941	Tx power right down; S/C AGC 045
	063000	S/C AGC up
	063026	10 cps modulation observed
	063035	Tx OFF
	063057	Rx switched to C-3; Rx out of lock
	063108	Rx in lock
	063124	Rx to 20 cps B/W
	063132	TM to S/C

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 19/201600 to 20/080508

SIG STR (dbm)	TIME (GMT)	REMARKS
-114.3	071448	Equidistant measurement; S/C AGC 035; gnd AGC PO 0.16 v
	074624	TM to decalock
	074717	Rx to 60 cps B/W
	075108	TM to S/C
	080139	Servo in pre-limits
	080323	TM to decalock
	080434	Rx out of lock momentarily
	080508	Rx out of lock

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 20/060743 to 20/095738

SIG STR (dbm)	TIME (GMT)	REMARKS
-131 -119.5	060743	Rx in one-way lock
	060800	TM started transmitting data to lab
	060924	
-118.4	061129	
	061134	Rate 4 sync; all rates in sync
	061208	
-117.4	061223	Antenna in slave
	061323	Rx in good data
	061405	
-116.4	061615	Rx noticed glitch; very momentary, but stopped counter
	061658	Counter restarted
	062324	
	062502	10 cps on Rx
	062530	Rx to bad data
	062550	TM to decalock
	062814	Rate 4 all rates in sync
	063000	Tx ON 200 w
	063004	Two-way lock
	063020	10 cps verified; two-way lock
	082300	1-RTC-0 initiated
	082338	1-RTC-0 verified
	082400	Verified rate 4 sync
	082500	2-RTC-0 initiated
	082538	2-RTC-0 verified
	082700	RTC-8 initiated
	082738	RTC-8 verified
	082740	B-20 event
-111.85	083140	B/W 28.2 to 31.8 Mc
	083000	AGC -1.07 v, variation 0.1 db
	083455	Receiving command message: RUMP
	083500	Decom to LO mode; B/W checks completed; normal
	083630	Command message SORT received
	074500	SC-6 initiated
	074538	SC-6 verified
	074541	B20 event
-111.5	074800	A 4.2 db shift
	074930	TM reports 4th TV stoppage
	075034	Rx reports panalyzor out of sync
	075200	Received command message: QUID
	075359	B/W checks completed; 28.1 to 31.8 mcs

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 20/060743 to 20/095738

SIG STR (dbm)	TIME (GMT)	REMARKS
-112.01	075637	Rx reports excessive noise on panalyzor
	080237	AGC -1.06 v, variation 0.1 db
	063030	10 cps OFF
	063245	Tx on synthesizer
	063326	Rx to good data
	063330	Rx to 20 cps
	063340	TM to S/C sync
	063723	Transfer time corrected from counter
	063402	Transient on TTY line; last half printed letters instead of numbers
	064454	Rate 4 sync; all rates in sync
-116.1	064727	Antenna back on drive tape; no offset required
	065502	AGC -0.779 v; variation 0.1 db
	065700	Antenna to 0.05 cps B/W
	070941	Tx OFF synthesizer
	070931	Rx to bad data
	071109	Tx ready for new frequency
	071120	Tx ON synthesizer
	071130	Rx to good data
	071448	Equidistant: -115.7 dbm, AGC -0.828 v; DN 35; S/C AGC -105 dbm
	072115	Rx reports signal level changes; maser reports no change
-112.9	072500	Command modulation ON
	072520	Tx reports Command Modulation amplitude correct
	072850	
	073200	TM reports 3rd stoppage on the TV; possibility of 2 bits data loss
	073700	1-RTC-0 initiated
	073738	1-RTC-0 verified
	073900	2-RTC-0 initiated
	073938	2-RTC-0 verified
	074100	SC-4 initiated
	074138	SC-4 verified
	074140	B20 event
	074144	B2-1 event
	074300	SC-5 initiated
	074338	SC-5 verified
	074341	B20 event
	083700	Voice verified on command message: RUMP and SORT
	084530	Temporary stoppage on TV; paper hangup

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 20/060743 to 20/095738

SIG STR (dbm)	TIME (GMT)	REMARKS
-111.8	084730	RTC-6 initiated
	084810	RTC-6 verified
	084810	B20 event
	084817	B-2-1 event
	085157	RCA has completed all final calibrations at Stations 11 and 12
	085237	RTC-8 loaded and waiting
	085742	B-2-1 event
	085745	AGC -1.074 v, variation 0.1 db
	091145	Maser reports no drift since last B/W checks; Rx verifies
	091441	B-2-1 event
	091617	Command Mod OFF
	091620	TDH to 1 sec sample; 10 sec sample to JPL at 091700
	091623	Rx to bad data
	091715	Tx OFF synthesizer
	092004	Tx ON synthesizer
	092024	Rx to good data
	092300	Command modulation ON 2.85 v; no changes
	092432	RTC-7 loaded and waiting
	092814	Rx reports occasional noise spikes
	093124	Clock pulse
	093309	Warm up 90 PT TM
	093313	B-2-1 event
	093434	Full power video both channels; Rx did not lose lock
-112	093550	All cameras functioning properly; all systems 'GO'
	093612	Lunar data via polaroid verified; F and P channels
	093700	TDH changed high speed tape
	093812	TV at Stations 11 and 12 functioning properly
	093813	B-2-1 event
	094008	
	094035	Both channels good; positive lunar video
	094125	Partially saturated video on Channel P and F good, as predicted
	094340	All cameras working; excellent video
	094437	Positive video on Channels P and F; P still partially saturated
	094517	Receiving same power level as at start

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 20/060743 to 20/095738

SIG STR (dbm)	TIME (GMT)	REMARKS
-112.2	094738	Good polaroid pictures; both channels operating as expected
	094848	Excellent video via polaroid; Stations 11 and 12 functioning well
	095027	Excellent video from all cameras
	095051	
-112.4	095054	Exceptionally good video from P channel cameras
	095321	Rx impact counter reset
	095400	Counter started
	095738	IMPACT! 095738.023238 on the counter, -1.04 v AGC

TABLE A-3
RANGER VIII TRACKING OPERATIONS SUMMARY

STATION : DSIF - 11

VIEW PERIOD: 20/062819 to 20/095738

SIG STR (dbm)	TIME (GMT)	REMARKS
-139	062819	Rx in lock
-117.3	064200	Rx was locked on sideband
-117.5	071500	
	071900	Notice occasional noise on panalyzer
-117.5	072500	
	074500	Noise spikes on panalyzer
-117.6	083000	
	083900	Bandwidth = 1.7 (low) and 2.0 mc = 3.7 mc total
-118.4	085800	
-118.4	091330	Noise spikes on panalyzer
-118.6	092430	
-118.4	093600	Partial scan ON 093428; full scan ON at 093431
-118.7	095307	Video still ON
	095738	Rx out of lock; IMPACT

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 71

VIEW PERIOD: 21/213702 to 21/214447

SIG STR (dbm)	TIME (GMT)	REMARKS
-56.5	174300	Acquire two-way lock prior to liftoff; locked up RWV; Rx patched RWV mode up in RF trailed to Tx
	175800	Antenna switched to omni system
	180000	TV off at this time
	180200	Transfer back to hi gain; AGC voltage -4.35 to 4.36 v
-56	180800	Status reported as green
	181100	VCO S-curve complete and directional antenna checked
	182400	Acquire two-way lock
	184000	Approx. time; reported several signal fluctuations
-74	184100	T-60 min and holding per built-in hold
	195600	Picked up countdown at T-60 min
	201400	Switched Tx power to high (-90 dbm) and verified two-way lock
	202000	Locked RWV Rx and patched RWV modulation to Tx
	202200	Rx AGC voltage -3.85 v; Pt. Tx power output +12 dbm for -90 dbm signal at transponder
	202600	Trailer reported as in green status
	210400	Resumed count at T-7 min; status reported as green
	210800	Recycled to T-7 min and holding
	213000	Picked up count at T-7 min
	213200	Transferred to internal RWR
	213702.5	Launch
	214447	Lost lock (normal) over horizon
	214625	Tx turned off

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF-51

VIEW PERIOD: 21/220100 to 092518

SIG STR (dbm)	TIME (GMT)	REMARKS
-94	220100	Rx in lock; GM-22
	220135	Servo in auto
	220400	Tx to 200 w
-97	220630	
	221015	Rx to bad data
	221140	Rx to good data
	221236	Rx to bad data
	221323	Rx to good data
	221444	Tx locked to synthesizer
-114	221550	
-145	223533	Signal strength dip
	223606	Tx on VCO
-108.2	225000	Steady
	225515	Tx on synthesizer
	231210	Tx on VCO
	231356	Tx locked to Rx synthesizer
	232218	Tx showed spikes on output; Rx dropped lock momentarily
-107.5	234000	
	234734	Rx momentarily dropped lock
	000215	Tx reduced power to 2 w
	000500	Tx OFF; Rx out of lock
	005380	Rx in lock; GM-32
	001000	Data stopped sampling to change rubidium standard
	001024	Rx out of lock
	001042	Rx in lock
	001527	Rx momentarily out of lock
	002041	Data started sampling; rubidium standard changed
	002100	Spikes gone from Tx
	002238	Rx out of lock
	002252	Rx in lock
	002520	Tx on; Rx out of lock
	002540	Rx in lock; GM-22
	003932	Rx to bad data
	004013	Rx to good data; clock adjusted to lead RWV by 46 msec
-112	004200	
	023958	Rx to bad data
	024000	Tx locked to Rx synthesizer
	024009	Rx to good data
	041620	Rx dropped lock momentarily; phase transient

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF-51

VIEW PERIOD: 21/220100 to 092518

SIG STR (dbm)	TIME (GMT)	REMARKS
-121.4	050334	Rx momentarily out of lock
	060600	Data to 1 min sample rate
	065949	Tx locked to synthesizer
	072232	Rx momentarily out of lock
	084000	10 cps modulation on
	084015	10 cps modulation off; Rx to 60 cps
	084228	Tx down in power
	084517	S/C AGC rise
	084522	Tx off
	084537	10 cps modulation observed
	084544	Rx to 20 cps
	084600	Switched to C-3; Rx out of lock
	084602	Rx in lock; GM-32
	084616	Rx out of lock
	084617	Aided track
	084619	Rx in lock
	084622	Auto track
	085500	Equidistant measurement: S/C AGC DN 032; S/C AGC -91.7 dbm; GND AGC PO 0.90 v
	085558	Rx out of lock for 1 sec
	085912	Servo in limits
-147	090600	Data stopped sampling
	091450	Sanborn off; all discriminators out of lock
	091600	
	092518	Rx out of lock; end of pass

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 21/230000 to 22/014400

SIG STR (dbm)	TIME (GMT)	REMARKS
	230000	Tracking data started
-142	230900	
-140	231540	
-140	232912	
	233500	
-141.5	234200	Track asked if we can give them main beam error channel readings
-138	234235	
-143	235530	
	235845	Rx out of lock for a few sec
	000022	Rx B/W to 60 cps
	000110	MDE to S/C from decalock for 400 cps; Rx out of lock
	000221	Rx doppler data to bad
	000400	Tx on
	000440	Rx to 10 cps
	000510	Rx out of lock for 10 sec; Rx in two-way lock
-122	000650	
	000710	Rx to good
	000840	Data on 10 sec sample rate
	001407	Rx out of lock for a few sec
-145	001701	
-146	002200	Unsteady
-149		
	002250	Rx out of lock for a few sec
	002314	Tx OFF
	002345	Rx in and out of lock for a few sec
	002500	Rx in lock; doppler data good; one-way
	002540	Rx out of lock
	003240	Data on 1 min sample rate
-146	003500	
-155	010655	
	010700	All rates out of sync
-155	011058	
-154	011710	
-156	012100	
-160	014320	Rx dropped lock for a few sec
	014440	Rx out of lock; end of track

TABLE A-4

RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 22/082410 to 22/171738

SIG STR (dbm)	TIME (GMT)	REMARKS
-143	082410	Rx in one-way lock; Rx in bad data
-139	082510	
	082616	Started transmitting TM data to JPL
	082720	All discriminators in sync and lock
	083007	Servo in slave
	083025	Rx to GOOD data
	083442	Verify S/C in Mode 1
	084002	10 cps mod from DSIF-51; 3 bursts
	084038	Rx to 60 cps B/W
	084050	A/S to decalock
	084104	Rx to bad data
	084130	Rx and decom back in lock
	084500	Tx on -200 KW; acquire two-way
	084533	10 cps mod on two-way lock confirmed
	084624	Rx in 20 cps B/W
	085500	Equidistant DSIF-51; S/C AGC data No. 34; ground signal level -122 dbm; AGC -0.483 v
-122	085810	AGC -0.490 v; variation 0.2 db
	091209	Voice transmission of command message: TROFT
	091421	Receiving command message: TROFT
	091500	Command Modulation ON
	092600	1-RTC-0 initiated
	092638	1-RTC-0 verified
-122.2	092730	AGC -0.465 v; variation 0.2 db
	092800	2-RTC-0 initiated
	092838	2-RTC-0 verified
	093000	RTC-3 initiated
	093038	RTC-3 verified
	093040	B-20 event
-131.0	093047	Signal level started decreasing
	093125	TDH restarted transmitting data to JPL at 092500
-109.8	093210	
	093322	Rx signal level as read on the curve -109.0 dbm; AGC -1.30 v
	093500	Rx reports doppler within 0.2 cps of predict
	094000	Command Modulation OFF
-109.4	100000	AGC -1.29 v; variation 0.1 db
-109.6	102529	AGC -1.28 v; 0.1 db variation
-109.5	110029	AGC -1.28 v; variation steady
-110	112800	Variation 0.2 db; AGC -1.25 v

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 22/082410 to 22/171738

SIG STR (dbm)	TIME (GMT)	REMARKS
-110.1	115245	AGC -1.24 v; variation 0.1 db
-110.7	122547	AGC -1.21 v; variation 0.1 db
-110.7	125622	AGC -1.21 v; variation 0.1 db
-110.3	133251	AGC -1.23 v; variation 0.1 db
-110.4	135624	AGC -1.22 v; variation steady
	135837	Rx noting impulse noise on panalyzor
	142000	Tx on with 10 cps; Rx reported all 3 bursts
	142030	Rx to bad data
	142040	Rx to 60 cps B/W
	142110	A/S to decalock
	142310	Tx reducing power to DN of 45
	142501	Rx reports glitch; Woomera in two-way lock
	142514	Tx off
	142656	Rx momentarily out of lock; changed doppler to C-3
	142819	Rx to good data
	142905	TM to S/C 400 cps
-110.3	143125	AGC -1.22 v; variation steady
	145800	Equidistant: -110.6 dbm; AGC -1.21 v; variation steady; S/C DN-36 corresponds to -109 dbm
-111	150900	
	152000	Rx in bad data 60 cps bandwidth
	152100	Woomera 10 cps observed
	152500	Tx on 200 kw
	152525	DSIF-12 10 cps on
	152528	Two-way lock confirmed
	152552	Rx to 20 cps B/W
	152557	Rx to good data
-111.3	152501	
-111.4	153800	AGC -1.16 v; steady variation
-111.6	155603	AGC -1.15 v; variation steady
	161500	Equidistant: Signal level -112 dbm; AGC -1.14 v; S/C DN 34 corresponds to -100 dbm
	162500	10 cps observed at DSIF-12; 3 bursts
	162524	Rx in bad data
	162550	Decom on decalock
	162540	Rx to 60 cps B/W
	162700	Tx starting to reduce power

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 22/082410 to 22/171738

SIG STR (dbm)	TIME (GMT)	REMARKS
	162840	Rx noticed bad doppler on scope at DSIF-41
	163027	Tx off; DSIF-41 in lock
	163108	Rx momentarily in and out of lock; TM verifies
	163146	Rx to 60 cps B/W
	163616	Borencamp glitch
	163811	Glitch on Rx
	164119	Rx to good data
	164729	Rx reports impulse noise on panalyzer
-112.1	165516	AGC -1.12 v; variation steady
-117.5	170817	Rx reports decreasing signal level
-120.9	170918	Servo on horizon
-127.1	171050	Decreasing rapidly
-130	171140	
	171523	Decom discriminators losing lock
	171738	Rx out of lock; discriminators out of lock

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 22/133448 to 23/03220

SIG STR (dbm)	TIME (GMT)	REMARKS
-140	133448	Rx acquired signal
-143	135900	Varying
-122	141140	From acquisition to track
-116	141400	
	141610	Servo to auto
-113	141800	
	142000	Rx to bad data
	142300	60 cps B/W
	142500	Tx on 200 w
	142530	Rx in two-way
	142640	Rx to good 20 cps B/W
	143400	Rx reports spurious 1.850 kc output on 45 kc wave analyzer output
	144600	Data sent to analog line -10 db
-113	150300	
	152112	Three 3 sec burst of 10 cps
	152210	60 cps B/W and doppler data bad
	152430	41 Tx reducing power by 10 db
	152710	RWR to good data and 20 cps B/W
	162300	Tx set Xa ready for transfer
	162532	10 cps mod observed
	162800	Doppler looks out of lock
	162632	All looks in lock
	163001	Tx on 200 w
	163102	Rx doppler to good; 20 cps B/W
	164340	Rx to good data
	165331	Tx increased from 190 w to 200 w
	220020	Command message code: CALL
		Send RTC. 0 at 222600;
		Send RTC. 0 at 222800;
		Send RTC. 2 at 223000
	220700	Battle short on ON Tx
	221038	Tx switched through command to RWV
	221145	Command modulation is ON
	221500	RTC 0 is loaded in RWV, system is GO
	223100	All commands went on time; punched out tape OK
	223430	Command modulation OFF
	223800	Battle short is OFF the Tx
	000020	Rx doppler data to bad Rx B/W 60 cps
	000330	Tx Xa changed
	000450	Doppler data to good

TABLE A-4

RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 41

VIEW PERIOD: 22/133448 to 23/03220

SIG STR (dbm)	TIME (GMT)	REMARKS
-125.6	000530	Rx B/W to 20 cps
	012430	Track requests stop sending tracking data
	012450	Rx to 60 cps B/W; S/C AGC 036
	012800	Tx reduced power by 10 db; S/C AGC 041
	013015	Rx sees 10 cps modulation; Rx bad doppler data
	013020	Tx OFF
	013106	Rx dopped lock for a few sec
	013110	Rx good doppler data
	042026	Servo brakes ON
	022600	Rx to acquisition-aid
	032200	Rx lost lock

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF-51

VIEW PERIOD: 22/213620 to 23/100440

SIG STR (dbm)	TIME (GMT)	REMARKS
-112	213620	Rx in lock; GM 32
	214500	Servo to auto track
	215335	Decom all rates in sync
	223040	B-20 Blip
	225500	Steady
	012415	Rx dropped lock momentarily
	012510	10 cps modulation observed
	012536	TM to external 400 cps
	012538	Rx to 60 cps B/W and bad data
	012820	S/C AGC 041
	013000	Tx on 200 w
	013010	Two-way confirmed
	013020	S/C AGC 035
	023300	Rx dropped lock momentarily six times to 031919
	031013	Rx to 60 cps B/W
	034559	CEC recorder indicates loss of TM tones momentarily
	090000	Rx to bad data
	090002	Tx changing VCO frequency
	090111	Tx locked to synthesizer
	090500	10 cps modulation
-115	090652	TM to internal 400 cps
	090700	Tx reducing power
	091014	S/C AGC 035
	091019	Tx off
	091037	10 cps modulation observed
	091120	Rx to C3
	091122	Rx out of lock
	091126	Rx in lock
	091240	TM to S/C
	092500	Equidistant measurements S/C AGC octal 034
	094243	Antenna at limits; brake on
	100440	Rx out of lock; data stopped sampling

TABLE A-4

RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 23/084600 to 23/174403

SIG STR (dbm)	TIME (GMT)	REMARKS
-140	084600	Rx acquired S/C
	084800	1st sample of data
	084900	All discriminators in sync
-126	085152	
-123	085250	
-120	085318	Signal level increasing
-117	085416	Signal level study
	085503	Servo in slave track
	085516	Rx in good data condition
	090016	All rates in sync
	090502	Rx 1st 10 cps mod burst from DSIF-51
	090536	Rx to bad data condition
	090751	S/C Rx AGC down -10db
	091000	Tx on and power; NCR
	091018	Tx on 200 w
	091035	DSIF 12 10 cps mod applied; two-way lock verified
-116.7	091214	
-116.49	092500	Equidistant measurement: AGC -0.86 v; S/C AGC DN35; S/C signal level -105 dbm
-116.7	100300	-0.85 v; AGC value
-116.6	102748	AGC -0.838 v; variation 0.1 db; Rx reports heavy impulse noise on panalyzor
	103500	Command modulation ON
	105000	1-RTC-0 initiated
	105038	1-RTC-0 verified
	105200	2-RTC-0 initiated
	105238	2-RTC-0 verified
	105400	SC-1 initiated 25-1007-0
	105438	SC-1 verified
-117.7	105600	SC-2 initiated; AGC -0.815 v; variation 0.1 db
	105638	SC-2 verified
	105800	SC-3 initiated
	105838	SC-3 verified
	110400	Command modulation OFF
	110456	Rx to bad data
	110742	Rx to good data
	110950	Receiving command message WALL
	111112	Voice verification of command message WALL with track
	111600	Command modulation ON
-117.9	102838	AGC -0.795 v; variation 0.1 db

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 23/084600 to 23/174403

SIG STR (dbm)	TIME (GMT)	REMARKS
	113100	1-RTC-0 initiated
	113138	1-RTC-0 verified
	113300	2-RTC-0 initiated
	113338	2-RTC-0 verified
	113500	RTC-3 initiated
	113538	RTC-3 verified
	113554	Signal level changing -123.4 dbm to -144 dbm
-140	113617	
-131	113639	Holding steady
-131.4	113716	Steady
-131	113953	AGC +0.165 v; variation 0.1 db
	114250	Receiving command message: X-RAY
	114307	Receiving command message: YOGA
	114430	Voice verification of X-RAY and YOGA with track
-130.8	115200	AGC +0.157 v; 0.1 db variation
	120300	RTC-4 initiated
	120338	RTC-4 verified
-130	120519	Steady
	120558	B-2-1 event
	120716	Receiving command message: ZINK
-130.9	120910	Approx 1 db variations but fairly steady
-130.5	121014	Signal level steady
-129	121448	
-132	121512	
-129	121537	
	121559	Varying between -129 and -132 dbm
-130	121837	Signal level holding
-133	121907	Signal level decreasing
-145	121931	
-138	121957	
-140	122027	
-137	122137	Signal level increasing
-131	122205	
-132	122425	Signal level holding
	123032	Rx noted significant doppler change
-142	123514	Signal level changing
-139	123602	Signal level increasing
-131	123808	Signal level increasing
-130	124139	Signal level holding
	124217	Doppler off by approx 3 cps
-131.1	125510	AGC +1.90 v; 0.1 db variation
	131423	Receiving command message: ADIZ
	132600	1-RTC-0 initiated

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 23/084600 to 23/174430

SIG STR (dbm)	TIME (GMT)	REMARKS
	132638	1-RTC-0 verified
	132800	2-RTC-0 initiated
	132838	2-RTC-0 verified
	133000	RTC-3 initiated
	133038	RTC-3 verified
-145	133058	Signal level decreasing
-120	133135	
-119	133203	
-118.5	133237	
-118.3	133420	
	133436	Command modulation off
-118.2	135536	AGC -0.75 v; variation 0.1 db
	145500	10 cps observed by Rx
	145520	Rx to bad data
	145555	Rx to 60 cps BW; AIS to decalock
	145730	Tx reducing power
	150010	DSIF-41 acquired two-way; actual time 150002.575:86
	150056	Tx off
-118.3	151536	AGC -0.745 v; 0.1 db variation
	151745	Rx reports heavy impulse noise on panalyzor
-118.2	152851	AGC -0.749 v; variation 0.1 db
	154103	Rx glitch stopped counter
	154203	Rx glitch stopped counter
-118.1	154330	
	154503	Rx glitch stopped counter
	154536	Rx to bad data
	154603	Rx glitch stopped counter five times to 155503
	155509	10 cps observed from DSIF-41
	155619	Rx to 60 cps B/W and bad data
	155625	AIS to decalock
	155639	Rx had glitch during change to two-way
	160000	Tx on
	160035	10 cps on; Rx observed
	160118	Rx to 20 cps B/W
	160123	Rx to good data
	160130	AIS to S/C AGC
-118.3	160200	AGC -0.750 v; variation 0.1 db
-118.3	162535	AGC -0.750 v; variation 0.1 db

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 23/084600 to 23/174403

SIG STR (dbm)	TIME (GMT)	REMARKS
	163600	NOTE: During 1st pass S/C AGC indicated Tx power was 7 db too high. During Post Cals the Tx precals were checked and verified correct. The forward power directional coupler was replaced, and power checks indicated power out was nominal, with the exception that dish-mounted test horn measured 0.6 mw lower than the expected 2.6 mw
-118.3	165153	AGC -0.750 v; variation 0.1 db
	165500	10 cps; observed at 165503
	165528	Rx in bad data
	165551	Rx to 60 cps B/W
	165601	AIS to decalock
	165533	Tx changing frequency
	165754	Tx reducing power
	165840	Tx to 10 db power level
	170003	Rx counter indicated out of lock
	170120	Tx off
	170148	Rx to 20 cps B/W
	170220	Rx to good data
	170700	S/C AGC at transfer (170120) was -108.6 with DSIF-12 Tx; and -106.9 with DSIF-41 Tx
-118.7	172553	AGC -0.71 v; variation 0.1 db
	173712	Servo reports horizon appearing on the antenna TV
-120	173755	Rx signal level beginning to decrease
-122	173859	
	174000	Antenna stopped
-125	174021	
-129	174123	
-135	174240	Impact control stopped
	174403	Rx out of lock

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF-41

VIEW PERIOD: 23/1404 to 24/033925

SIG STR (dbm)	TIME (GMT)	REMARKS
-134	140400	Rx in lock
	140800	Rate 1 & 2 in sync
	141000	
	143000	TM data to data line at -10 db
-118	143940	Rx on main beam
	145200	Tx tuned; ready for transfer
	145500	10 cps MCD observed
	145600	Rx in two-way; TM data poor (side band)
-117	145628	Rx in two-way main beam
	145709	Doppler 3 cps high on predicts
	150000	Tx on at 200 w
	154000	
-117.5	155500	Three bursts of 10 cps modulation
	155712	Tx reduced by 10 db
	160021	Tx off
	162600	Antenna returned to conventional ACQ aid
-117.5	165600	MDE to decalock; Rx to two-way
	170001	Tx on 200 w
	173300	
	180900	Rx out of lock
	181342	Servo to auto
	181320	Rx in lock
	181410	Rx out of lock momentarily
	181704	Rx in two-way lock
	222455	HA glitch; reasons unknown
	225500	10 modulation being sent out
	225530	Seen at 41
	225610	ACQ modulation off
	225730	Tx forward power reduced by 10 db S/C AGC
	225940	S/C AGC 036
	230047	Tx off
	230120	Rx out of lock for a few sec
-119	230235	
	235510	10 cps modulation seen at DSIF 41
	235700	S/C AGC 040
	000000	Tx on
	000022	Tx acquisition is ON; 10 cps MOD on; Rx in two-way lock
	000110	Tx modulation off
	000119	Rx to 20 cps B/W
	014845	Servo to bad; Rx to 60 cps
	014950	Xa change complete
	015050	Good data; 20 cps bandwidth
	015129	Modulation on

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF -41

VIEW PERIOD: 23/1404 to 24/033925

SIG STR (dbm)	TIME (GMT)	REMARKS
	015530	Tx break mod
	015500	Tx reducing power by 10 db
	015715	Tx -10 db down
	015834	Rx to 60 cps and bad doppler
	020048	Tx off
	020258	Transfer complete
	021908	TM data transmission resumes
	023400	Decom to HI-LO mode
	023507	Servo to prelimits; brakes on brake-mode
	023949	Acq track to Acq
	033925	Stop all station recording; antenna to Zenith

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 23/214325 to 24/102145

SIG STR (dbm)	TIME (GMT)	REMARKS
-115.5	214325	Rx in lock; started recorders
	215830	Servo in auto
	220350	Rx taken out of lock; anomalous signal
	220425	Rx in lock; discriminators unable to lock up
	220453	Rx taken out of lock; wide-band phase detector re-phased
	220703	Rx in lock
	220728	Decom in sync
	225500	10 cps modulation observed
	225535	Rx to 60 cps bandwidth
	225540	TM to decalock
	225550	Rx to bad data
	225557	Rx to C2
	225745	S/C AGC down
	230000	Tx on; 200 w; GM-22
	230040	10 cps verification
	230115	Rx to good data
	230125	Rx to 20 cps bandwidth
	230130	TM to S/C
	230313	Rx momentarily dropped lock
	232912	Rx momentarily out of lock
	235500	10 cps modulation on
	235530	Rx to 60 cps bandwidth
	235540	TM to decalock
	235620	Tx power down 10 db
	235717	Rx to bad data
	000045	10 cps modulation observed
	000100	Tx off; GM-32
	000108	Rx to 20 cps bandwidth
	000119	Doppler switch to C-3
	000125	Rx momentarily out of lock
	000224	Rx in lock
	000234	Rx to good data
	003220	Rx momentarily out of lock to 011812
	015500	10 cps modulation observed
	015517	Rx to 60 cps bandwidth
	015530	TM to decalock
	015542	Doppler switch to C-2
	015547	Rx to bad data
	020000	Tx on 200 w; GM-22
	020014	10 cps verified two-way
	020044	Rx to good data
	020052	Rx to 20 cps bandwidth

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 51

VIEW PERIOD: 23/214325 to 24/102145

SIG STR (dbm)	TIME (GMT)	REMARKS
-119.25	020104	TM to S/C
	043559	Rx momentarily out of lock
	050742	2 sec Rx drop lock
	074254	Rx momentarily out of lock
	085945	Rx to bad data
	090052	Tx Xa change
	090142	Rx to good data
	090500	10 cps modulation on
	090715	Tx 10 db down in power
	091027	10 cps modulation observed
	091031	Tx off; GM-32
	091245	Rx to 20 cps bandwidth
	092758	Momentary drop of Rx lock
	093418	4 sec drop of lock
	095250	Servo in limits
	095448	Equidistant measurement: S/C AGC DN 035 -105.1 dbm; Gnd AGC P0.425 v
	101600	Data stopped sampling
	102145	Rx out of lock; end of pass

TABLE A-4

RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 24/085049 to 24/140821

SIG STR (dbm)	TIME (GMT)	REMARKS
-145	085049	Rx in lock
	085130	TM data to JPL
-140	085441	Holding steady
	085540	RCA reports all systems green
-133	085640	
-128	085730	
-122	085847	
	090003	Servo in slave
	090111	Doppler number on predicts
-120	090112	
	090503	10 cps observed from DSIF-51; 3 bursts seen
	090855	Receiving command message: BLIP
	091000	Tx on 200 kw
	091022	10 cps observed from DSIF-12; S/C in two-way acquisition
	091111	Rx to good data
-119.4	091450	
	091528	Cancelling RTC-5 procedure at DSIF-12 discretion; will do so only on instructions from SFOF
	092612	AIS reports they have noticed a glitch, 1 pulse time after beginning of the H-9 sync; this was noticed on pass 2 and now on pass 3
	094225	Servo optimizing HA coordinates
	094707	Servo completed offsets optimization; no offsets required, excursions of 0.1 to 0.2 deg
-119.2	095448	Equidistant signal level; AGC -0.713 v; variation 0.2 db S/C Ch 40 DN 36 = -109 dbm
	101655	Rx impact controls stopped; apparently on noise; reset
-119.2	110001	AGC: -0.710 v; variation 0.1 db
	113700	Rx to bad data; Tx changing frequency
	113843	Rx to good data
	114300	Command Modulation ON
	114420	Command Modulation at 2.8 v
-119.3	115147	AGC: -0.714 v; variation 0.1 db
	115200	Cancel commands until 115400
	115400	1-RTC-0 initiated
	115438	1-RTC-0 verified
	115600	2-RTC-0 initiated
	115638	2-RTC-0 verified
	115800	SC-4 initiated
	115838	SC-4 verified
	115842	B-20 event

TABLE A-4
RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF- 12

VIEW PERIOD: 24/085049 to 24/140821

SIG STR (dbm)	TIME (GMT)	REMARKS
-119.4	115845	B-2-1 event
	120000	SC-5 initiated
	120038	SC-5 verified
	120042	B-20 event
	120200	SC-6 initiated
	120238	SC-6 verified
	120241	B-20 event
	121109	Receiving command message: CALL
	121510	Command Mod OFF
	122545	Rx, 178312 impact cntr stopped; reset and started at 122700
	124000	Beginning bandwidth checks; impact counter stopped; Channels 1 and 2 required no readjustment
	124343	Completed bandwidth checks; system good; 28.1 to 31.8 mcs
	124400	Receiving command message: EGAR
	124710	Command Modulation ON
	125522	AGC: -0.707v; variation 0.1 db
	125907	Track reports not going on timed sequence with RTC-6
	130234	RTC-6 initiated
	130312	RTC-6 verified
	130315	B-20 event
	130320	B-2-1 event
	130343	B-2-1 event
	131244	B-2-1 event
	131400	B-2-1 event
	131700	RTC-5 initiated
	131738	RTC-5 verified
	131741	B-20 event
-119.4	131750	RCA reports TV clock is off; AIS verifies
	131800	Decom indicates Mode 4
	131840	Receiving command message: FLEW
	132949	B-2-1 event
	133119	B-2-1 event
	133234	SFOD instructs unload RTC-8; load RTC-7
	133600	Rx reports doppler on predicts; signal level steady
	134811	RCA reports no indication of warmup
	134816	B-2-1 event
	134835	RCA reports warmup

TABLE A-4

RANGER IX TRACKING OPERATIONS SUMMARY

STATION : DSIF - 12

VIEW PERIOD: 24/085049 to 24/140821

SIG STR (dbm)	TIME (GMT)	REMARKS
-119.2	134934	Video on both channels; P Channel on approximately 1/2 sec before F Channel; signal level holding
	135100	Rx reports doppler on predicts
-119.4	135130	RCA reports video good on all 6 cameras
	135314	B-2-1 event
	135502	AGC: -0.716 v; variation 0.1 db
	135720	Track reports pictures good
	135818	Rx out of lock; lost Tx; following one-way predicts; counter showed 135806.428516; dropped decom sync
	135914	Rx on predicts; discrim back in lock; Rx in one-way lock in two-way mode; TV recovered
	140030	Rx to bad data
	140055	Tx time delay 2 min timed out
	140415	Rx reset counter-triggered at 140500
	140550	AIS Channel 4 measure shows a ripple not present before
	140639	Rx to reset counter at 140700; started
	140821	Impact! Control shows 140821.327997

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The descriptions of the four *Ranger* spacecraft, the flight plans, and the mission synopses are extracted from published material on the *Ranger* project and are presented in this Memorandum to provide a better understanding of the Deep Space Network operations.